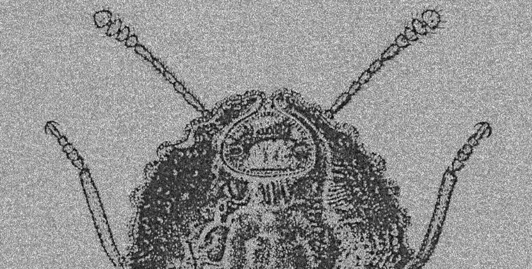
THE AUSTRALIAN
Entomologist
published by
THE ENTOMOLOGICAL SOCIETY OF QUEENSLAND



Volume 32, Part 1, 11 March 2005
Price: $6.00 per part

ISSN 1320 6133

THE AUSTRALIAN ENTOMOLOGIST

The Australian Entomologist is a non-profit journal published in four parts annually by the Entomological Society of Queensland and is devoted to entomology of the Australian Region, including New Zealand, Papua New Guinea and islands of the south-western Pacific. Articles are accepted from amateur and professional entomologists. The journal is produced independently and subscription to the journal is not included with membership of the Society.

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Cover: The New Caledonian *Aoupinia pseudohelea* Matthews (Coleoptera: Tenebrionidae) bears a striking resemblance to Australia's pie-dish beetles of the genus *Helea*. However it belongs to the unrelated Gondwanan tribe Adeliini. This species is known only from the Aoupinie Special Fauna Reserve that straddles New Caledonia's central mountain massiff between Poya and Ponerihouen. It is a ceptic species living within rainforest leaf litter. Illustration by Geoff Thompson.

PSEUDOCOCCUS GOODENIAE WILLIAMS (HEMIPTERA: PSEUDOCOCCIDAE) AND ITS PARASITOIDS IN THE PILBARA OF WESTERN AUSTRALIA

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Abstract

Pseudococcus goodeniae Williams, previously known only from the Erskine Range in northern Western Australia, is recorded from Karijini National Park in the Pilbara region. The mealybug was observed at high densities on its host plant *Goodenia stobbsiana* (Goodeniaceae). Several hymenopteran parasitoid species were reared from *P. goodeniae*, including *Xenanusia pulchripennis* Girault, *Cheiloneurus* Westwood sp., two unidentified species of Encyrtinae (all Encyrtidae) and *Euryischia* Girault sp. (Aphelinidae). This is the first published host association for a species of *Xenanusia* Girault.

Introduction

Exploration for parasitoids of the Pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green), was conducted from 1999 to 2001 in tropical and subtropical eastern and northern Australia (Goolsby *et al.* 2002). During this exploration effort, collections of several mealybug species and their parasitoids were made in the Pilbara of Western Australia. One mealybug, *Pseudococcus goodeniae* Williams, was particularly abundant during our survey of the Pilbara and is the subject of this paper.

Materials and methods

Surveys were conducted on 6 May 2001, at Fortescue Camp (22°28.19'S, 118°33.27'E) and Weamo Gorge (22°21.46'S, 118°17.17'E) in Karijini National Park, located in the Pilbara region of Western Australia.

After field collection, the mealybugs were held in paper cans streaked with honey and held in a humiditron (Debach and Rose 1985) at 70% RH for emergence of parasitoids. Mealybugs were sent to John Donaldson in Brisbane and parasitoids to Michael Gates in Washington D.C. for identification and vouchering.

Collections by the Australian Biological Control Laboratory (ABCL) were assigned a specific site collection number. Each accession number is unique, prefaced by the acronym for the laboratory with the year collected, a three digit serial number associated with the field collection, followed by a sequential specimen number (*i.e.* ABCL 2000809.007). If an organism is later exported to the United States for a biological control program, the number is used as an identifier in the ROBO (Releases of Beneficial Organisms) database that is maintained by USDA-Agricultural Research Service.

Results and discussion

Pseudococcus goodeniae was collected feeding on *Goodenia stobbsiana* F.Muell. (Goodeniaceae). The plant was common along the walking tracks in the National Park, with high densities of mealybugs on all the plants we encountered. Mr Kevin Cameron, a local aboriginal ranger familiar with the native plants of the Pilbara, indicated that he had never before noted an outbreak of mealybugs on *G. stobbsiana*. We did not observe *P. goodeniae* on any other plant species in the vicinity of the collections.

P. goodeniae was previously known only from the type series, collected in 1980 from *Goodenia* sp. in the Erskine Range of northern Western Australia (Williams 1985). Several hymenopteran parasitoid species, mostly encyrtids, were reared from *P. goodeniae* (Table 1). *Xenanusia pulchripennis* Girault was the most common parasitoid in the collection and this is apparently the first host record for a species of *Xenanusia* Girault (Noyes 2003). This is the first Australian host record for a species of *Euryischia* Girault (Aphelinidae), although the genus has been recorded attacking an unidentified species of *Pseudococcus* Westwood in India (Agarwal 1970). The *Cheiloneurus* Westwood species could be a hyperparasite of *X. pulchripennis*.

Table 1. Parasitoids (all Hymenoptera) recovered from *Pseudococcus goodeniae*.

Species and family	ABCL #	Location	Date
Xenanusia pulchripennis Girault	2001840.002	Fortescue Camp	6.v.2001
[Encyrtidae]			
Euryischia sp.	2001840.003	Fortescue Camp	6.v.2001
[Aphelinidae]	2001840.004		
	2001840.005		
Cheiloneurus sp.	2001840.007	Fortescue Camp	6.v.2001
[Encyrtidae]	2001840.008		
	2001841.002	Weamo Gorge	6.v.2001
Encyrtinae sp.1	2001840.006	Fortescue Camp	6.v.2001
[Encyrtidae]	2001840.011		
	2001841.003	Weamo Gorge	6.v.2001
	2001841.004		
Encyrtinae sp.2	2001840.009	Fortescue Camp	6.v.2001
[Encyrtidae]	2001840.010		

Acknowledgements

The authors would like to thank Jeff Makinson (Australian Biological Control Laboratory, CSIRO Entomology, Indooroopilly) for curation of the parasitoids; Michael W. Gates (USDA-ARS, Systematic Entomology Laboratory, Washington, D.C.) for identification of the parasitoids; John

Donaldson (Queensland Department of Primary Industries and Fisheries, Indooroopilly) and Penny Gullan (University of California, Davis, CA) for identification of *P. goodeniae*; Steve Van Leeuwin (Conservation and Land Management, Karratha, Western Australia) for identification of *G. stobbsiana*; and Kevin Cameron and the Karijini people of Western Australia for access to their tribal lands.

References

AGARWAL, M.M. 1970. Some new chalcidoid parasites recorded from Aligarh (India) (Hymenoptera, Encyrtidae). *Musi* **44**: 25-29.

DEBACH, P. and ROSE, M. 1985. Humidity control during shipment and rearing of parasitic Hymenoptera. *Chalcid Forum* **4**: 11-13.

GOOLSBY, J.A., KIRK, A.A. and MEYERDIRK, D.E. 2002. Seasonal phenology and natural enemies of *Maconellicoccus hirsutus* in Australia. *Florida Entomologist* **85**: 494-498.

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MISCELLANEOUS NOTES

The following notes on new butterfly distributions are abstracted from the *News Bulletin of the Entomological Society of Queensland* and were first published during 2003 and 2004 in the volumes and parts indicated.

Tisiphone abeona (Donovan) [Nymphalidae]. Two previously unrecorded populations for 'southern subspecies' are reported from Mount Maroon and Mount Barney National Parks in SE Qld. The Mount Maroon population appears closest to *T. a. morrisi* Waterhouse [known from near Jacobs Well, SE Qld], whereas specimens from near the summit of Mount Barney are closer to [subsequently confirmed as the 'northern form' of] *T. a. regalis* Waterhouse, the latter a subspecies previously known from the Main Divide between Barrington Tops, NSW and Stanthorpe, Qld. More specimens are needed to determine the subspecies appropriate for each locality. - Protected areas - Michael and Don Sands - **31**(2): 36-37 (2003).

Acrodipsas illidgei (Waterhouse & Lyell) [Lycaenidae]. One male was collected near Leyburn, west of the Darling Downs in SE Qld, in February 1999, the previous western limit being Toowoomba. It was collected in a swampy area among mature belah (*Casuarina cristata*). Other than the Toowoomba record, this species has been mainly associated with mangrove communities. - New butterfly records - Michael and Don Sands - **31**(3): 47 (2003).

Hypocysta euphemia Westwood [Nymphalidae]. One male was collected hilltopping on Mount Maroon, SE Qld in May 2003. The previous northern limit of distribution was the Lamington Plateau. - Correction to new butterfly records in News Bulletin 31 (3) 47 - Michael and Don Sands - **31**(4): 64 (2003).

Hesperilla crypsargyra (Meyrick) [Hesperiidae]. A population was discovered in an area of dense, low montane heath with scattered shrubs on rhyolite rock, near Binna Burra in the Lamington National Park, SE Qld, in late November 2002. On 15 November 2003, adults were abundant from 9-10 am, with males flying close to the ground along a walking track, but nearly all had dispersed by 11 am. Males were dominant with only a few females observed. A larva and a pupa were found on *Gahnia insignis* in December 2002 and November 2003 respectively. Previously, *H. crypsargyra* was only known in Qld from an historical site near Stanthorpe. Preliminary examination of specimens shows them to be morphologically closest to *H. c. crypsargyra* from southern NSW and markedly different from the montane *H. c. hopsoni* Waterhouse from northern NSW. It is likely that this new population represents an isolated but distinct northern subspecies and investigations into this are continuing. - A new population of *Hesperilla crypsargyra* in southern Queensland - Peter Wilson - **31**(9): 169-170 (2003[2004]).

Hesperilla donnysa Hewitson [Hesperiidae]. One larva was found on 31 December 2003 in heath land 12 km SW of Rainbow Beach, SE Qld. The prepupal larva was discovered in a shelter made from two obliquely cut leaves near the base of a medium sized tussock of *Gahnia sieberiana* growing in a swamp. The larva pupated two days later and an adult female emerged on 14 January 2004. The new locality is a northern range extension for this southern endemic Australian skipper, approximately 65 km from the previously known record of 10 km NE of Yandina on the Sunshine Coast, SE Qld. - A new Queensland distribution record for *Hesperilla donnysa* (Trapezitinae: Hesperiidae) - Andrew Atkins - **32**(1): 22 (2004).

NEW GENERA, SPECIES AND RECORDS OF ADRAMINI (DIPTERA: TEPHRITIDAE: TRYPETINAE) FROM THE SOUTH PACIFIC AND SOUTHERN ASIA

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Abstract

Papuadrama buna gen. n., sp. n. is described from Papua New Guinea. *Kedadrama* gen. n. is proposed for the Malaysian *K. bifasciata* (Hardy), comb. n., transferred from *Euphranta* Loew. *Coelotrypes luteifasciatus* (Senior-White), comb. n. is transferred from *Euphranta* and newly recorded from India, while *C. flavinus* (Hering) and *C. punctilabris* (Bezzi) are newly recorded from Solomon Islands and *C. latilimbatus* (Enderlein) is newly recorded from southern Thailand. *Crinitisophira* Hardy and *Cr. bicolor* Hardy are newly synonymised with *Cyclopsia* Malloch and *Cy. inscripta* (Walker) respectively, while *Cyclopsia univittata* Hardy is newly recorded from Papua New Guinea and West Malaysia. *Hardyadrama excoecariae* Lee and *H. magister* (Lee) are newly recorded from Papua New Guinea and *H. presignis* (Hardy) is newly recorded from East Malaysia. *Acinoeuphranta* Hardy and *A. zeylanica* Hardy are newly synonymised with *Piestometopon* de Meijere and *P. luteiceps* de Meijere respectively. The Indian genus *Indophranta* Agarwal & Kapoor is transferred to the Pyrgotidae. A key to genera is provided.

Introduction

Following our recent study of Australian and Pacific Trypetinae (Hancock and Drew 2003), a small collection of adramine fruit flies was sent to us from the University of Hawaii. This collection, containing several new species and records, had provisionally been sorted and studied by the late D. Elmo Hardy. Here we deal with genera other than *Euphranta* Loew, which was treated by Hancock and Drew (2004). Several additional Indo-Malayan genera and species are also discussed, including two removed from *Euphranta*.

The following collection acronyms have been used: AMS - Australian Museum, Sydney; ANIC - Australian National Insect Collection, Canberra; BMNH - The Natural History Museum, London; BPBM - Bernice P. Bishop Museum, Honolulu; NMNH - National Museum of Natural History, Washington D.C.; PSU - Prince of Songkla University, Hat Yai, Thailand; QMB - Queensland Museum, Brisbane; SASB - Slovak Academy of Sciences, Bratislava; UH - University of Hawaii, Honolulu.

Systematics

Coelopacidia sp.

Material examined. INDIA: 1 ♂, 'India, W.W. Saunders, 1868-4' (BMNH).

Comments. Previous reports of '*Coelopacidia cylindrica*' from India (Hardy 1977, Kapoor 1993), based on the lectotype of *Trypeta cylindrica* Walker (in BMNH), actually refer to *Chyliza cylindrica* (Walker) (= *pallidipes* Lamb) [family Psilidae]. However, there is a specimen of *Coelopacidia* Enderlein in BMNH with identical collection data plus a label '*cylindrica*' in Walker's handwriting, an apparent manuscript name. It resembles the African *C. strigata* Bezzi but the wing has the apical brown spot broader and there is a

faint yellow band over DM-Cu crossvein. In Africa, species of *Coelopacidia* use the stems of *Senecio* (Asteraceae) and *Polemannia* (Umbelliferae) as larval hosts.

Coelotrypes flavinus (Hering)

Material examined. SOLOMON ISLANDS: 1 ♀, Santa Isabel, Kolotuve, 20.vi.1960, C.W. O'Brien, light trap; 1 ♀, New Georgia group, Ghizo I., Gizo, 0-200 m, i.1974, N.L.H. Krauss (both BPBM).

Comments. This species is newly recorded from the Solomon Is, being known previously from mainland Papua New Guinea and the Bismarck Archipelago.

Coelotrypes latilimbatus (Enderlein)

Material examined. THAILAND: 2 ♀♀, Prince of Songkla University, Hat Yai, Songkhla District, 22.iv.1993, S. Permkam (PSU).

Comments. This is a very variable species and the above specimens (Fig. 1) appear to belong here. It is separated from *C. circumscriptus* (Hering) by the hyaline rather than fulvous costal cells and the largely black thorax and abdomen. Known previously from Sumatra and the Philippines, it is newly recorded from southern Thailand.

Coelotrypes luteifasciatus (Senior-White), comb. n.

Material examined. SRI LANKA: Holotype ♀, Suduganga, 17.viii.1921, R. Senior-White, on window, BM 1924-100; 1 ♀, same data except 25.vii.1922 (both BMNH). INDIA: 1 ♀, Dohnavur, 350', Tinnevelly Dt, 3.x.1938, BM-CM Expedn to South India, Sept-Oct 1938; 1 ♀, Kerala, sp. 9, no date, ex sweet potato weevil [*sic*], CIE A20272 (both BMNH).

Comments. Staurella luteifasciata Senior-White has characters typical of *Coelotrypes* Bezzi (Permkam and Hancock 1995, Senior-White 1922) and is transferred from *Euphranta*. Known previously from Sri Lanka, it is newly recorded from southern India. Species in genus *Coelotrypes* Bezzi breed in the flower buds of *Ipomoea* (Convolvulaceae) and sweet potato (*I. bataca*) is a likely host.

Coelotrypes punctilabris (Bezzi)

Material examined. SOLOMON ISLANDS: 1 ♂, Santa Cruz group, Nendo I., Graciosa Bay, 0-70 m, i.1977, N.L.H. Krauss (BPBM).

Comments. This species, known previously from Fiji, Tonga and Western Samoa, is newly recorded from the Santa Cruz group, eastern Solomon Is.

Cyclopsia inscripta (Walker)

Comments. Crinitisophira Hardy shows no characters differentiating it from *Cyclopsia* Malloch (Hardy 1974, 1983, 1986) and is placed here as a new synonym of the latter. Its type species, *Crinitisophira bicolor* Hardy, is placed as a new synonym of *Cyclopsia inscripta* (Walker). This species occurs from Maluku in Indonesia to the Bismarck Archipelago in Papua New Guinea. A hyaline indentation in wing cells m or $m+r_{4+5}$ is present or absent.

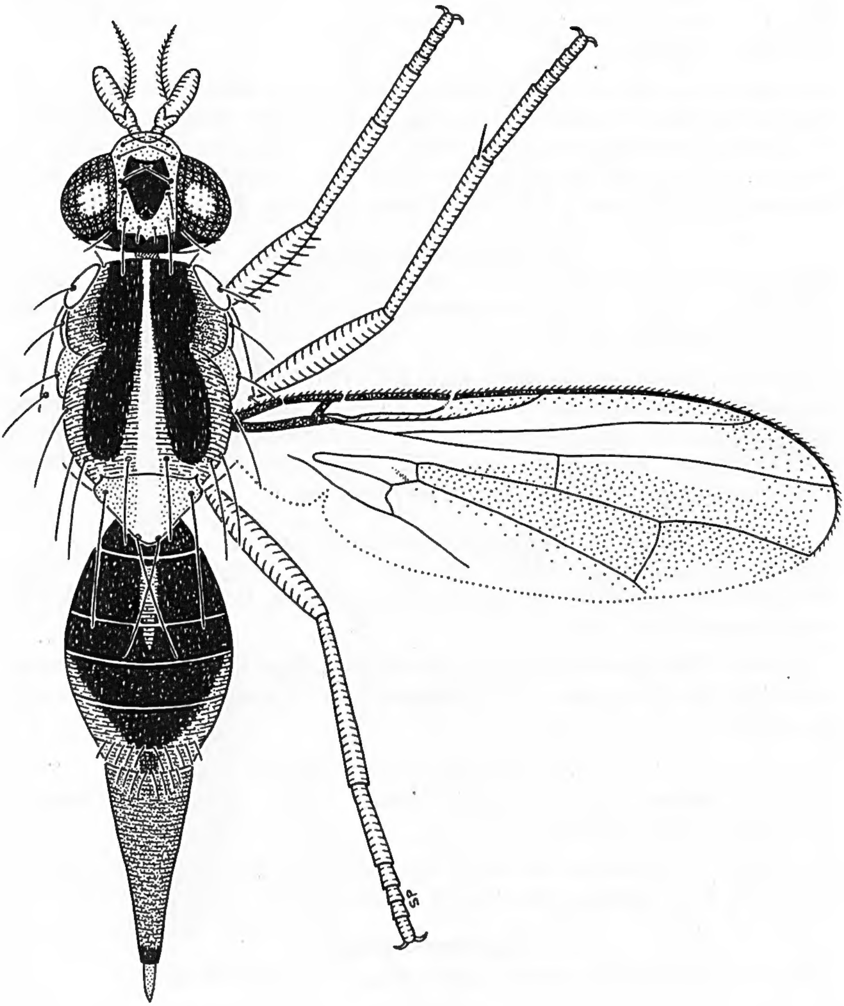


Fig. 1. *Coelotrypes latilimbatus*, female.

Cyclopsia univittata Hardy

Material examined. PAPUA NEW GUINEA: 1 ♂, New Britain, Mt Sinewit, 3500', 27.vi.-17.ix.1963, W.W. Brandt (ANIC). MALAYSIA: 1 ♀, Pahang Distr., 30 km NE Raub, Lata Lembik, 3°56'N, 101°38'E, 200-400 m, 22.iv.-1.v., 8-15.v.2002, E. Jendek & O. Sauša (SASB).

Comments. This species differs from *C. inscripta* in lacking the dark brown patch across the R-M crossvein. Known previously only from the Philippines, it is newly recorded from Papua New Guinea and Malaysia. In the New Britain male, the hyaline indentation in the apical brown patch on the wing does not extend beyond cell m, but all other characters appear typical.

Hardyadrama excoecariae Lee

Material examined. PAPUA NEW GUINEA: 1 ♂, Central Province, Hisiu, 22.iii.1986, J.W. Ismay, swept coastal pandanus (UH); 1 ♂, same locality, 22.iii.1986, J.W. Ismay, mangroves (UH).

Comments. This species is newly recorded from Papua New Guinea. Known previously from Singapore, Brunei and Australia, Hardy (1974) also recorded it from Mindanao, Philippines (as 'new genus near *Adrama*'). Its host plant is the mangrove *Excoecaria agallocha* (Euphorbiaceae). In the above specimens, postpronotal setae are present but weak.

Hardyadrama magister (Lee)

Material examined. PAPUA NEW GUINEA: 1 ♂, 1 ♀, Central Province, Hisiu, 22.iii.1986, J.W. Ismay, swept coastal pandanus; 1 ♀, same locality, 22.iii.1986, J.W. Ismay, mangroves (all UH).

Comments. This species is newly recorded from Papua New Guinea. Known previously from Singapore and Australia, its host plant is also *Excoecaria agallocha*.

Hardyadrama presignis (Hardy)

Material examined. MALAYSIA: 1 ♀, Sabah, Tenompok [near Kota Kinabalu], 13.ii.1959, T.C. Maa (BPBM).

Comments. This species is newly recorded from Borneo. It was known previously from southern Thailand, Philippines and Torres Strait, Australia.

***Kedadrama* gen. n.**

Type species *Euphranta bifasciata* Hardy, 1981, by present designation.

Diagnosis. Head with 2 pairs of frontal and 1 pair of orbital setae; postocellar setae present and black; ocellar setae vestigial; third antennal segment elongate, as long as face; arista pubescent; face with 2 large, shining black spots; frons with an oblong medial black spot situated between frontal and orbital setae. Thorax with presutural setae absent; postpronotal, dorsocentral and prescutellar acrostichal setae present; 4 scutellar setae; anatergite with fine, long pale hairs; metathoracic postcoxal area semimembranous medially.

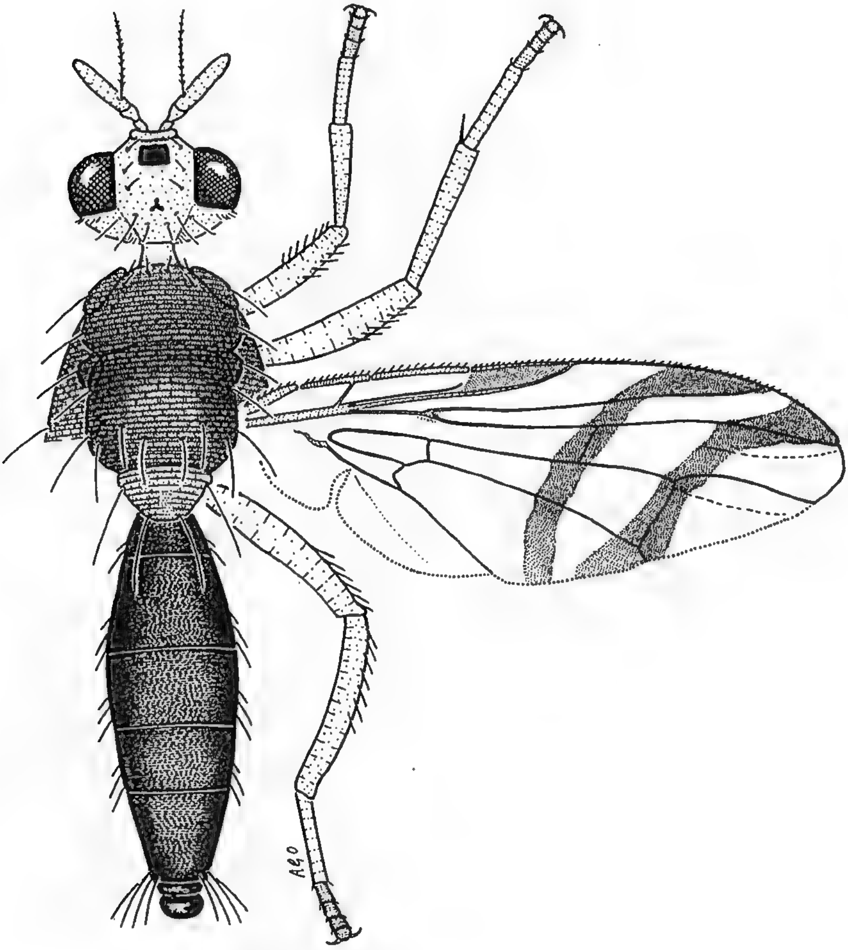


Fig. 2. *Kedadrama bifasciata*, male.

Wing with pterostigma relatively narrow and elongate; R-M crossvein placed near apical two-thirds of cell dm and well beyond apex of pterostigma; cell bcu apically produced and acute. Legs fulvous; fore femur with two rows of small but distinct anteroventral and posteroventral spines over apical three-fifths. Abdomen with terga I+II elongate, at least as long as terga III plus IV combined; tergite V 1.5 times longer than tergite IV.

Comments. *Kedadrama* is similar in appearance to *Adrama* Walker and *Hardyadrama* Lee but postocellar and acrostichal setae are present and only the fore femur has two rows of short, black, ventral spines. This latter character has not been seen elsewhere in the Adramini and is a distinguishing character of the genus, also excluding it from *Euphranta*. In related genera where two rows of short ventral spines occur on the legs, these are on the mid or mid and hind femora. The wing pattern and elongate abdomen of the type species (Fig. 2) resemble those of *Adrama* and *Hardyadrama* more closely than anything seen in *Euphranta*.

Kedadrama bifasciata (Hardy), comb. n.

Material examined. MALAYSIA: Holotype ♂, Kedah Peak, 3300 ft, 22.iii.1928, H.M. Pendlebury (QMB).

Comments. Described from Kedah, West Malaysia (Hardy 1981), this species was placed originally in *Euphranta*. The wing is hyaline with a brown pterostigma and two oblique brown bands enclosing the R-M and DM-Cu crossveins respectively.

***Papuadrama* gen. n.**

Type species *Papuadrama buna* sp. n., by present designation.

Diagnosis. Head with 2-3 pairs of frontal and 1 pair of orbital setae; postocellar setae present and black; ocellar setae vestigial; third antennal segment about half length of face; arista plumose; face and frons without black markings. Thorax with presutural setae absent; postpronotal, dorsocentral and prescutellar acrostichal setae present, the dorsocentrals weak; 4 scutellar setae; scutum and scutellum with a medial yellow vitta; Anepisternum with a broad yellow posterodorsal patch, not extending to postpronotal lobes; anatergite with fine, long pale hairs; metathoracic postcoxal area semimembranous medially. Wing with pterostigma longer than broad; R-M crossvein placed near apex of cell dm and well beyond apex of pterostigma; cell bcu apically produced and acute. Legs fulvous; mid femur with two rows of small but distinct anteroventral and posteroventral spines. Abdomen elongate; oviscape very long, the apical half narrowed and cylindrical.

Comments. *Papuadrama* is most similar in appearance to *Hardyadrama* but the antennae are shorter, postocellar and acrostichal setae are present and only the mid femora have two rows of short, black, ventral spines. This latter character also occurs in *Adramoides* Hardy (tribe Acanthonevrini) and

Scolocolus Hardy but those genera differs in several other characters. The medial yellow vitta on the scutum and scutellum of the type species also resembles that seen in *Coelotrypes* but the shorter antennae, spinose mid femora and different biology exclude it from the latter genus.

Papuadrama buna sp. n.

(Figs 3-4)

Types. Holotype ♂, PAPUA NEW GUINEA: 24 km W. Lae, Morobe District, 19.xi.1972, G.A. Holloway (AMS). *Paratypes*: 3 ♂♂, 1 ♀, Nawatabanda logging area, nr Bulolo, 1.vii.1979, H. Roberts, 1331 (AMS); 1 ♀, Saputa, near Buna, Papua Terr., 1943-44, Robert B. Sperry (NMNH).

Description. Male (Fig. 3). Length of body 9.5 mm, of wing 8.0 mm. Head slightly higher than long; fulvous; face yellow, concave; epistome produced; antennae fulvous, third segment apically rounded, about half length of face; arista plumose. Setae black: 2 pairs frontals (sometimes 3 on one side), the upper pair widely separated from the lower and close to line of orbitals; 1 pair orbitals; ocellars vestigial; postocellars and inner and outer verticals well developed; postoculars thin; genal thin.

Thorax fulvous, with a narrow yellow-white medial vitta from suture to end of scutellum, broadest posteriorly; a triangular yellow-white patch on upper portion of anepisternum; katatergite yellow-white; anatergite with long, fine hairs; metathoracic postcoxal bridge semimembranous. Setae black: outer scapulars (inner pair absent); postpronotal; 2 pairs notopleural; supra-alar; postalar; intra-alar; acrostichal prescutellar; dorsocentrals thin, weak, placed close to line of postalars; 4 long scutellars; 1 anepisternal; 1 anepimeral; 1 katepisternal; presuturals absent. Haltere fulvous. Legs fulvous; fore femur with preapical brown setae; mid femur with anteroventral and posteroventral rows of short, stout black spines; mid tibia with a long, apical black spine.

Wing elongate; veins R_1 and R_{4+5} setose; pterostigma fulvous, about 2.5 times longer than broad and gradually tapered; R-M crossvein near apex of cell dm, about half its own length from DM-Cu crossvein and well beyond apex of pterostigma; cell bcu apically produced and broadly acuminate. Pattern very pale yellow over basal and median two-thirds, leaving cell c almost hyaline and separated from apical brown patch by a transverse hyaline band; apical brown area encloses both RM and DM-Cu crossveins; apex of cell r_{4+5} hyaline; cell m with a hyaline indentation posteriorly.

Abdomen fulvous to pale brown; elongate; terga I+II about as long as terga III plus IV combined; tergite V about 1.8 times length of tergite IV and with a terminal row of 6 black setae; surstylus short.

Female. Length of body (excluding oviscape) 8.0 mm, of wing 8.0 mm, of oviscape 3.5 mm. As for male except abdominal characters: tergite VI about 0.7 length of tergite V; ovipositor (Fig. 4) with oviscape about as long as rest of abdomen, conical at base, tapering abruptly and with apical half narrow

and cylindrical; base fulvous, narrow apical part brown; aculeus apically acute with a pair of small preapical dentations.

Host plant. This species was reared from fruit [possibly seeds] of *Dysoxylum gaudichaudianum* (Meliaceae) by H. Roberts (AMS data).

Etymology. Named after the village of Buna.

Distribution. Known only from eastern Papua New Guinea.

Comments. As noted in the generic comments, this species is distinctive. The biology of *P. buna* also differentiates it from species placed in related genera such as *Hardyadrama* (which breed in mangroves) and *Coelotrypes* (which breed in flower buds of *Ipomoea*: Convolvulaceae). The wing pattern is very similar to that of *Euphranta bilineata* Hardy but the two are not allied.

Undescribed genus and species

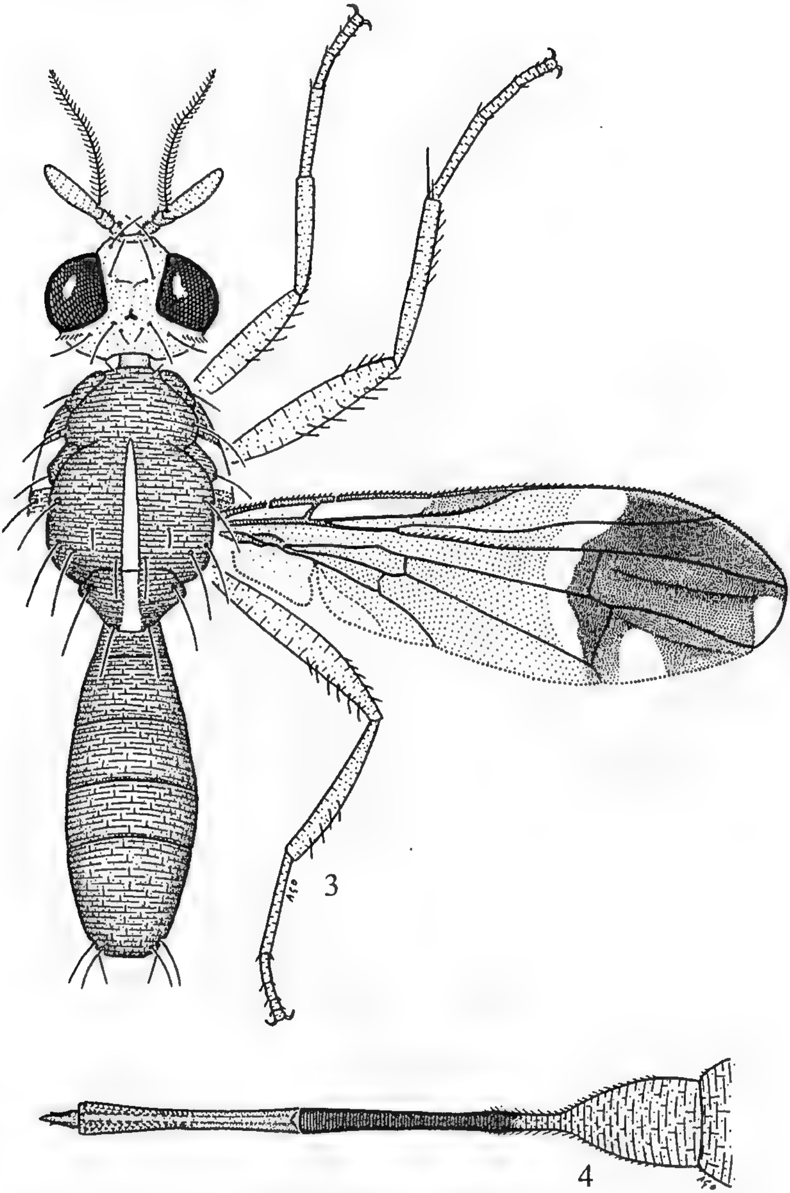
Material examined. SOLOMON ISLANDS: 1 ♀, Choiseul I., Kitipi R., 80 m, 13.iii.1964, P. Shanahan, malaise trap (BPBM).

Comments. This taxon resembles *Cyclopsia* and *Brandtomyia* Hardy in the vertical face and *Euphranta* in thoracic setal characters and the extensively brown wing pattern (similar to that of *E. vitabilis* Hardy but without the hyaline costal indentation beyond the pterostigma), whereas the relatively elongate third antennal segment is similar to that of *Adrama ismayi* Hardy.

The following combination of characters distinguishes it from all described genera in the Adramini: largely black in colour, with no yellow prescutellar or scutellar medial markings; face vertical, not concave; third antennal segment elongate, a little longer than face and with the arista plumose; wing cell dm not hatchet-shaped, R-M crossvein placed below apex of pterostigma and vein Cu_1 bare; metathoracic postcoxal bridge semimembranous medially; no stout spines on fore, mid or hind femora; genal, postocellar, postpronotal and dorsocentral setae present and 4 scutellar setae. The specimen is in too poor a condition to describe.

Discussion

One undescribed and thirteen described genera of Adramini (= Euphrantini) are now known from the region from southern [peninsular] Thailand to Australia and the South Pacific: *Adrama* Walker, *Brandtomyia* Hardy, *Coelotrypes* Bezzi (= *Staurocneros* Hering), *Cyclopsia* Malloch (= *Crinitisophira* Hardy, syn. n.), *Dimeringophrys* Enderlein, *Euphranta* Loew (= *Paraeuphranta* Hardy), *Hardyadrama* Lee, *Ichneumonosoma* de Meijere, *Kedadrama* nov., *Papuadrama* nov., *Piestometopon* de Meijere (= *Elleipsa* Hardy; = *Acinoeuphranta* Hardy, syn. n.), *Scolocolus* Hardy and *Soita* Walker (= *Phantasmiella* Hendel). Most are small (1-4 species), with only *Adrama*, *Coelotrypes* and *Euphranta* containing a larger number of described species (12, 17 and 102 respectively).



Figs 3-4. *Papuadrama buna* gen. n., sp. n. (3) male; (4) female ovipositor.

All Australasian genera have long, fine hairs on the anatergite. Five additional genera from this region or the southern Philippines, all lacking these hairs, were included in the Adramini by Hardy (1986). One, *Adramoides* Hardy, has spinose mid femora and an apparently non-setose aculeus but otherwise resembles *Antisophira* Hardy, *Heterosophira* Hardy [a synonym of *Sophira* (*Kambangania*) de Meijere], *Pseudosophira* Malloch and *Terastiomyia* Bigot, all of which lack femoral spines and have preapical setae on the aculeus. All are referable to the *Sophira* complex in tribe Acanthonevrini.

Four additional genera of Adramini occur in the Oriental Region: *Coelopacidia* Enderlein, *Meracanthomyia* Hendel, *Pelmatops* Enderlein and *Pseudopelmatops* Shiraki. The Sri Lankan genus *Acinoeuphranta* Hardy (Hardy 1971) is placed as a new synonym of *Piestometopon* de Meijere, with *A. zeylanica* Hardy placed as a new synonym of *P. luteiceps* de Meijere, known previously from Singapore to Tonga (Permkam and Hancock 1995). *Paraeuphranta* Hardy, from Maluku, Indonesia, was synonymised with *Euphranta* by Hancock and Drew (2004).

The Indian genus *Indophranta* Agarwal & Kapoor was placed in tribe Adramini by Agarwal and Kapoor (1989) but is transferred here to the family Pyrgotidae. Its sole species, *I. humerata* Agarwal & Kapoor, shows characters typical of that family, reviewed recently by Korneyev (2004), particularly the genus *Adapsilia* Waga.

Key to genera of Australasian Adramini

Coelopacidia is not known east of India but might occur. It keys to couplet 7 but has no stout ventral spines on the femora, a micropubescent arista and two midtibial apical spines (one in other genera except *Soita*).

1 Wing vein Cu_1 setose; scutum with presutural setae .... *Soita* Walker
- Wing vein Cu_1 bare; scutum without presutural setae 2

2 Metathoracic postcoxal bridge broadly sclerotised; postocellar and genal setae both absent; two or four scutellar setae 3
- Metathoracic postcoxal bridge semimembranous medially; postocellar and genal setae not both absent; four well developed scutellar setae 4

3 Mid and hind femora each with two rows of short, stout ventral spines; wing with apical area largely brown .... *Adrama* Walker
- Mid and hind femora without rows of short, stout ventral spines; wing with a narrow brown costal band .... *Ichneumonosoma* de Meijere

4 Scutum with a medial yellow-white vitta continuing over scutellum; if indistinct then postocellar and prescutellar acrostichal setae absent and mid and hind femora with two rows of short, stout ventral spines........... 5
- Not as above; scutum with medial yellow-white vitta often absent, if present then not continuing over scutellum 7

5 Anepisternum with a subtriangular yellow dorsal patch not reaching postpronotal lobe or wing base; mid femora with two rows of short, stout ventral spines; postocellar setae present .... *Papuadrama* nov.

- Anepisternum with a yellow dorsal band joined to postpronotal lobe and extending to wing base; if mid femora with rows of stout ventral spines then hind femora also spined and postocellar setae absent 6

6 Postocellar and prescutellar acrostichal setae absent; face yellow; arista at most short-pubescent; mid and hind femora with or without two rows of stout ventral spines .... *Hardyadrama* Lee

- Postocellar and prescutellar acrostichal setae present; face usually with a large black spot on lower margin; arista pubescent to plumose; mid and hind femora without stout ventral spines .... *Coelotrypes* Bezzi

7 One or more of fore, mid and hind femora with two rows of short, stout ventral spines; arista almost bare or pubescent 8

- Femora without rows of stout ventral spines; arista usually plumose ... 10

8 Only fore femora with stout ventral spines; wing without a short transverse band from pterostigma and with two oblique brown bands over R-M and DM-Cu crossveins .... *Kedadrama* nov.

- Mid and often hind femora with stout ventral spines; wing with a short transverse band from pterostigma and a large brown subapical area enclosing both R-M and DM-Cu crossveins 9

9 Hind femora with ventral spines; 3 pairs of frontal setae; postpronotal setae present; arista almost bare .... *Piestometopon* de Meijere

- Hind femora without spines; 2 pairs of frontal setae; postpronotal setae absent; arista pubescent .... *Scolocolus* Hardy

10 Wing cell dm hatchet-shaped, distinctly narrowed basad of R-M crossvein; dorsocentral setae absent .... *Brandtomyia* Hardy

- Wing cell dm normal, not distinctly narrowed basad of R-M crossvein; dorsocentral setae present though sometimes weak 11

11 Antennae a little longer than face; face vertical; postocellar and postpronotal setae present; wing pattern brown and R-M crossvein placed below apex of pterostigma .... Undescribed genus

- Antennae shorter than face; face usually concave medially, if almost vertical then postocellar and postpronotal setae absent, wing pattern yellow and brown and R-M crossvein placed beyond apex of pterostigma 12

12 Face almost vertical, slightly concave near oral margin; dorsocentral setae rudimentary; postocellar, postpronotal and prescutellar acrostichal setae all absent; two pairs of frontal setae placed close together .... *Cyclopsia* Malloch

- Face concave in medial portion; dorsocentral setae often well developed; postocellar setae present; postpronotal and prescutellar acrostichal setae often present, if both absent and two pairs of frontal setae then these are widely spaced 13

13 One pair of frontal setae; orbital setae often absent; wing pattern reduced and faint, little more than a costal band .... *Dimeringophrys* Enderlein

- Two or more pairs of frontal setae; one pair of orbital setae present; wing pattern usually extensive and distinct .... *Euphranta* Loew

Acknowledgements

Dick Tsuda (UH) and Keith Arakaki (BPBM) forwarded specimens for study, including those held by their institutions as loans from other collections, *viz.* AMS, ANIC, Ismay Collection, Kovac Collection and Sperry Collection (NMNH). Nigel Wyatt (BMNH) facilitated access to specimens in his care and Bernhard Merz (MHNG) sent specimens on loan from SASB. Bert Orr and Susan Phillips prepared the illustrations. All this assistance is gratefully acknowledged.

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Australian Entomologist, 2005, **32** (1): 17-35

A NEW SPECIES OF *HYPOLYCAENA* C. & R. FELDER (LEPIDOPTERA: LYCAENIDAE) FROM AUSTRALIA AND ITS RELATIONSHIP WITH *H. PHORBAS* (FABRICIUS)

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Abstract

Hypolycaena litoralis sp. n. and its life history are described and illustrated from Torres Strait, Queensland. It belongs to the 'branded' *Hypolycaena* C. & R. Felder group, with males possessing a sex brand (a patch of androconial scales) on the forewing upperside and their larvae attended by the ant *Oecophylla smaragdina* (Fabricius). The 'branded' *Hypolycaena* species that occur in the region are reviewed and the external facies and genitalia of *H. litoralis* are found to most closely resemble those of *H. phorbas* (Fabricius). Adults and early stages are compared with *H. phorbas* and the differences between the two species discussed. The behaviour of adult and larval *H. litoralis* is documented and a description of the species' habitat included. Host plants are mangroves, *Rhizophora stylosa* Griff. and *Bruguiera* Sav. sp. (Rhizophoraceae). Currently, *H. litoralis* is known from Boigu, Dauan, Saibai and Yam Islands, Torres Strait.

Introduction

The genus *Hypolycaena* C. & R. Felder occurs in the Afrotropical and Indo-Australian regions, with about 30 species known (Parsons 1998). The genus is particularly diverse in tropical Africa. Closer to Australia, six species occur in Papua New Guinea, of which two extend into tropical Australia (Braby 2000). Parsons (1998) summarised the current view concerning the placement of particular species within *Hypolycaena*. He pointed out that Corbet and Pendlebury (1978) and D'Abrera (1978) both recognised two widely separate groups of species: the 'true' *Hypolycaena* (as in the type species *H. sipylus* (C. Felder)) that lack a sex brand on the forewing and with larvae that have no association with ants and feed exclusively on orchids, and the 'branded' *Hypolycaena*, characterised by possessing a sex brand on the forewing, exhibiting a high degree of sexual dimorphism and with polyphagous larvae closely associated with *Oecophylla* Smith ant species.

Four 'branded' *Hypolycaena* species occur in the Australian region: *H. erylus* (Godart), *H. periphorbas* Butler, *H. phorbas* (Fabricius) and *H. dictaea* C. & R. Felder. The only species currently recognised in Australia is *H. phorbas* (Braby 2000). Parsons (1998) also recorded *H. dictaea* from 'as far south-east as Queensland'; however, a review of specimens in The Natural History Museum, London and the Australian National Insect Collection (ANIC), Canberra by the authors has failed to support this claim.

A further species, *H. noctula* (Staudinger), was described from two 'dark grey tinted slightly bluish' males from Cooktown, Queensland (Staudinger and Schatz 1888). Waterhouse (1903) initially agreed with Staudinger and Schatz (1888) in recognising *H. noctula* but later (Waterhouse and Lyell 1914) synonymised this species with *H. phorbas*. Tindale (1923) agreed with this synonymy and it is accepted in this work. *H. noctula* and *H. phorbas* share the same type locality (Edwards *et al.* 2001).

In 1984, several small, dark 'branded' *Hypolycaena* males closely resembling *H. phorbas* were collected by C.G. Miller and J.W. d'Apice on Yam Island in Torres Strait, Queensland. Additional specimens were collected over the next decade on other Torres Strait islands. Because the facies and size of *H. phorbas* are known to be variable (Parsons 1998, Braby 2000), these specimens were presumed, until recently, to be diminutive examples of *H. phorbas*, which also occurs on the same islands. A review of *Hypolycaena* from the Indo-Australian region (Corbet and Pendlebury 1978, D'Abrera 1978, Parsons 1998), plus an examination of Papua New Guinea material in the Brandt Collection (in ANIC) by one of us (CEM), indicated that this small, dark 'branded' *Hypolycaena* might be distinct.

In April and May 2002, all immature stages of this small *Hypolycaena* were discovered by one of us (CEM) on Dauan and Saibai Islands on *Rhizophora stylosa* Griff. (Rhizophoraceae) and were successfully reared to adults. Further examination of this species' external facies, genitalia and life history confirmed that it was undescribed.

Abbreviations of specimen depositories are: ANIC - Australian National Insect Collection, Canberra; CEMC - C.E. Meyer collection, Canberra; CGMC - C.G. Miller collection, Lennox Head; JFDC - J.F. Donaldson collection, Thornlands; TLIKC - Joint T.A. Lambkin and A.I. Knight collections, Brisbane; JWDC - J.W. d'Apice collection, ANIC, Canberra; MDBC - M. De Baar collection, Brisbane; MTQ - Museum of Tropical Queensland, Townsville; PSVC - P.S. Valentine collection, Townsville; QM - Queensland Museum, Brisbane; RPWC - R.P. Weir collection, Darwin; SSBC - S.S. Brown collection, Bowral. Abbreviations of collectors are: AIK - A.I. Knight; CEM - C.E. Meyer; CGM - C.G. Miller; JFD - J.F. Donaldson; JWD - J.W. d'Apice; PSV - P.S. Valentine; RPW - R.P. Weir; SJJ - S.J. Johnson; SSB - S.S. Brown; TAL - T.A. Lambkin.

Hypolycaena litoralis **Lambkin, Meyer, Brown & Weir, sp. n.**

Mangrove Flash (Figs 1-4, 9-12, 17-18, 21-29)

Types. Holotype ♂, AUSTRALIA (QUEENSLAND): labelled 'Boigu Island, Torres Strait, Q. 8-9.iv.1992, T.A. Lambkin' (in QM, Registration No. T.123514). *Paratypes*: 3 ♂♂, 3 ♀♀, same data as holotype except 21.iii.1994 (3 ♂♂, 1 ♀ TLIKC, 1 ♀ ANIC, 1 ♀ MDBC); 23 ♂♂, 14 ♀♀, Dauan Island, Torres Strait, 9.v.2001 (9 ♂♂, 9 ♀♀), 27.iv.2000 (♂), 11.iv.2001 (♂), 1.v.2001 (3 ♂♂), 10.v.2001 (♂), 11.v.2001 (5 ♂♂, 2 ♀♀), 12.v.2001 (♀), 13.v.2001 (3 ♂♂, 2 ♀♀) AIK (TLIKC); 2 ♂♂, same data except

17.ii.2004 (pupa collected) TAL (TLIKC); 14 ♂♂, 8 ♀♀, same data except 13-18.iv.2001 (1 ♂, 1 ♀), 26.iv.-2.v.2002 (7 ♂♂, 4 ♀♀), Emg: 3.v.2002 (♀), Emg: 5.v.2002 (♂), Emg: 12.v.2002 (♂), Emg: 14.v.2002 (♂), Emg: 16.v.2002 (♂), Emg: 10.vi.2002 (♀), Emg: 12.vi.2002 (♂), Emg: 18.vi.2002 (♂), Emg: 7.vii.2002 (♀), CEM (CEMC); 1 ♂, same data except 4.iv.1990, JFD (JFDC); 9 ♂♂, 6 ♀♀, same data except 13.iv.1994 (♂), 9°24S, 142°32E, 4.iv.2004 (♂), 9.iv.2004 (2 ♂♂), 12.iv.2004 (4 ♂♂, 1 ♀), emerged 12.iv.2004 (2 ♀♀), emerged 13.iv.2004 (♀), emerged 14.iv.2004 (♀), emerged 16.iv.2004 (♂), emerged 23.iv.2004 (♀), PSV (PSVC); 8 ♂♂, 8 ♀♀, same data except 9.412S, 142.529E, 10.iv.2004 (2 ♂♂, 1 ♀), emerged 12.iv.2004 (♀), emerged 14.iv.2004 (1 ♂, 2 ♀♀), emerged 18.iv.2004 (1 ♂, 3 ♀♀), emerged 19.iv.2004 (3 ♂♂), emerged 20.iv.2004 (♀), emerged 22.iv.2004 (♂), SJJ (MTQ); 7 ♂♂, 6 ♀♀, same data except 9°24'46"S, 142°32'19"E, 26.iv-2.v.2002 (2 ♂♂, 1 ♀), 26.iv-2.v.2002, em 3.v.2002 (3 ♀♀), 26.iv-2.v.2002, em 4.v.2002 (3 ♂♂, 1 ♀), 26.iv-2.v.2002, em 5.v.2002 (2 ♂♂, 1 ♀), RPW, SSB & CEM (RPWC); 18 ♂♂, 9 ♀♀, same data except 13-18.iv.2001 (1 ♂, 1 ♀), 26.iv-2.v.2002 (17 ♂♂, 7 ♀♀), 5.v.2002 (ex pupa) (♀), SSB (SSBC); 2 ♂♂, Saibai Island, Torres Strait, 27.ix.1992, 22.iii.1994, TAL (TLIKC); 1 ♂, 1 ♀, same data except 9.v.2001 (♂), 27.ii.2004 (♀) AIK (TLIKC); 2 ♂♂, 2 ♀♀, same data except 19-20.iv.2001 (1 ♂, 2 ♀♀), 25.iv.2001 (♂), CEM (CEMC); 2 ♂♂, same data except 3-4.v.2002, SSB (SSBC); 2 ♂♂, Yam Island, Torres Strait, 3.iv.1984, CGM (CGMC); 2 ♂♂, same data except JWD (JWDC); 10 ♂♂, same data except 12.vi.1992, AIK (1 ♂ ANIC, 3 ♂♂ JFDC, 6 ♂♂ TLIKC). All specimens are documented as vouchers in Appendix 1 (♂♂) and Appendix 2 (♀♀).

Description. Male (Figs 1, 3). Forewing length 13.14 mm [n=106]. Forewing upperside ground colour dull black, largely covered, most often with deep blue-purple but sometimes blue central area enclosing a velvety black sex brand, variable in size and shape but never circular; sex brand rarely extending below vein CuA_2 and almost always overlaid by a line of blue-purple scales in the area between veins CuA_1 and CuA_2; rarely with white markings on the forewing in the area below the sex brand above vein 1A+2A. Hindwing upperside variably suffused with blue-purple; a series of faint white subterminal lunules sometimes occurring up to vein M_2 but, when present, always poorly defined; the two lunules nearest the tornus always present and each enclosing a black spot; tornal lobe dull black, sometimes with a dull orange centre; a fine white terminal line running from the tornal lobe up to but not past vein M_2; termen with two black tails tipped white at veins CuA_2 and 1A+2A. Forewing underside ground colour pale grey, with a short pale brown to grey band at end of cell; a similar almost straight post median band faintly edged with white; a faint pale grey subterminal band. Hindwing underside ground colour pale grey, with a dark grey or black basal spot; a short pale brown to grey band at end of cell; an irregular yellow-brown post median band faintly edged with white finishing at tornus; two black spots near tornus each edged above with pale orange.

Male genitalia (Figs 17-18). Sociuncus slightly convex in lateral view with acute ventral angle, concave in ventral view; brachium in ventral view long, tapering, curved with extreme apex bent; valva long, with thumb-like process

near apex, in lateral view tapering with acute apical portion bent dorsally, in ventral view slightly sinuate with apical portion curved laterally, basal lateral extension of valva short and rounded; ventral-lateral carina usually only slightly developed, never strongly laminate (n=6, voucher specimens 14, 23 [Holotype], 24, 25, 31 and 32 [Appendix 1]).

Female (Figs 2, 4, 29). Forewing length 13.67 mm [n=57]. Forewing upperside ground colour ranging from dull grey-black to grey-brown, rarely with a trace of white in the central area of the forewing. Hindwing upperside with a series of dull black subterminal spots with no obvious white lunules enclosing them; a fine white terminal line running from the tornal lobe up to but not past vein M_1; tornal lobe dull black enclosing a very small dull orange centre; tails as for male. Underside as in male, but ground colour paler.

The underside ground colour and wing patterns are variable in both sexes.

Distribution. This species is known from Boigu, Dauan, Saibai and Yam Islands, Torres Strait, Queensland.

Etymology. The specific name is derived from the Latin noun *litus* meaning 'shore' and refers to the littoral zone or seashore environment where this species occurs.

Life history

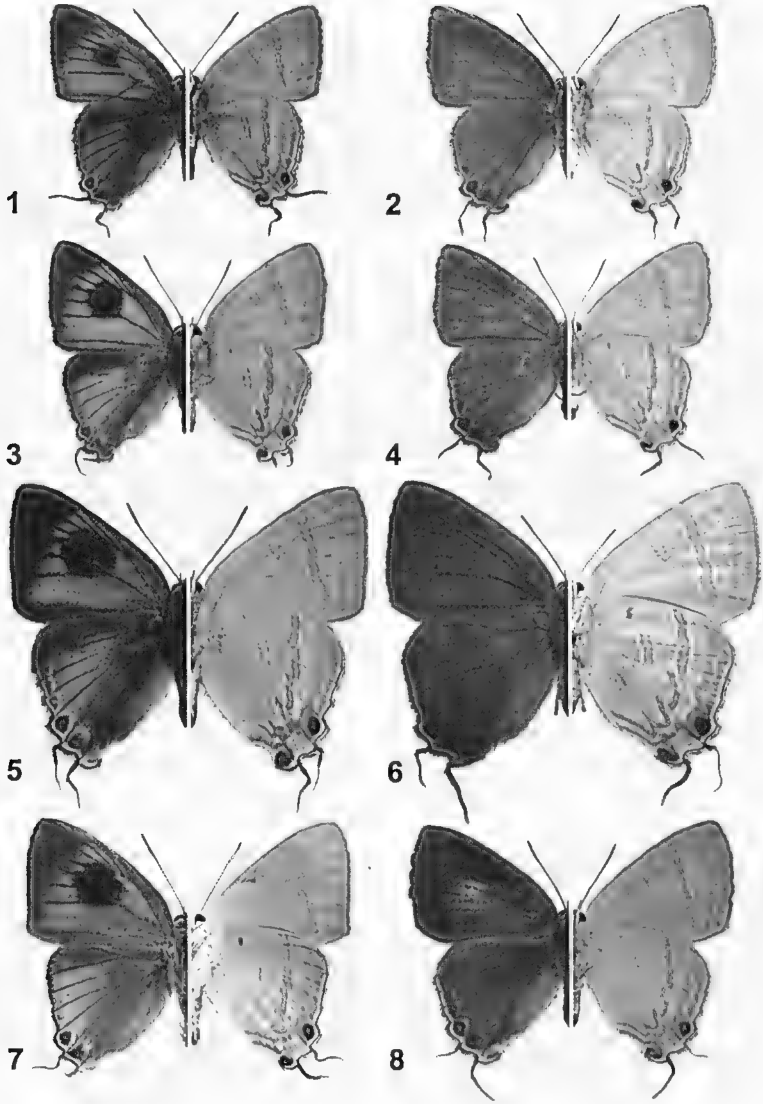
Host plants (Figs 30-32). *Rhizophora stylosa* Griff. and *Bruguiera* Sav. sp. (Rhizophoraceae).

Attendant ant (Figs 24, 28). *Oecophylla smaragdina* (Fabricius), green tree ant, brown form (Formicidae).

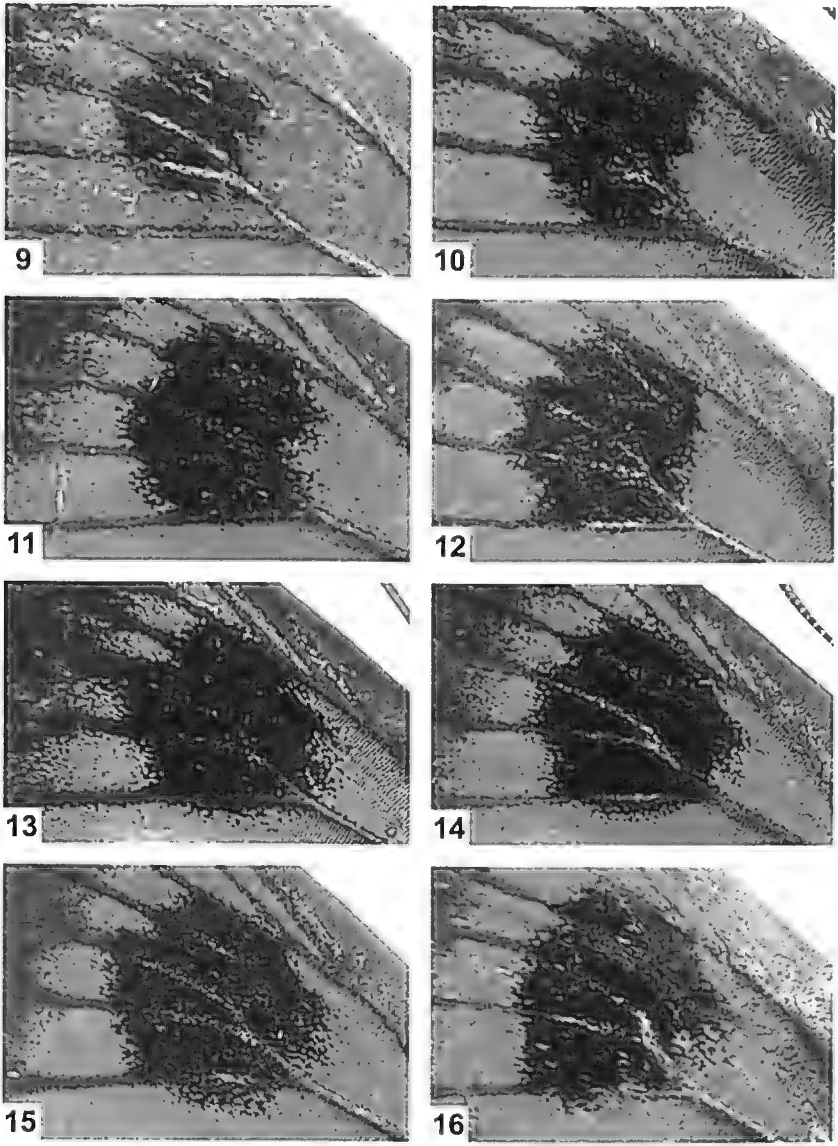
Egg (Figs 21-22). Width 0.65 mm, height 0.36 mm [n=1]; white, mandarin-shaped; micropylar depression smooth with no ornate features; egg surface with a pattern of reticulated pits and intervening ridges with tops of ridges obtuse and granulated.

First instar larva (Fig. 23). Length 1.0 mm [n=3]; body smooth and onisciform, pale green with no distinctive external features except for the body contents, visible through the cuticle, appearing as a broad dark green dorsal stripe extending from the first mesothoracic to the last abdominal segment.

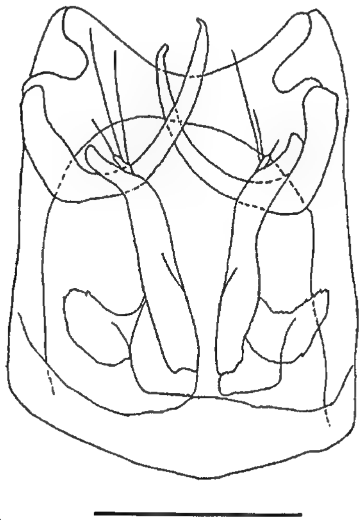
Final instar larva (Figs 24-25). Length 17.0 mm [n=7]; head orange; body onisciform and elongate; body, including prothoracic and anal plates, varying in colour from pale to dark green; pale green lateral and dorsolateral stripes; two faint white dorsal stripes edged reddish brown; a central dorsal dark green stripe; spiracles orange; dorsal surface of first mesothoracic segment orange; area between dorsolateral eversible organs on abdominal segment 8 orange; legs and prolegs, including bases, pale green; prothoracic plate, anal plate, leg and proleg bases edged in fine pale secondary setae.



Figs 1-8. *Hypolycaena* spp. All figures to scale, upperside left, underside right [forewing lengths in parentheses]. (1-4) *H. litoralis* with voucher specimen numbers (VS): (1, 3) males: (1) Dauan I., AIK [13 mm] VS 4; (3) Boigu I., TAL [15 mm] VS 9; (2, 4) females: (2) Dauan I., AIK [15 mm] VS 1; (4) Boigu I., TAL [15 mm] VS 15. (5-8) *H. phorbas*: (5, 7) males: (5) Dauan I., 11.v.2001, AIK [18 mm]; (7) Boigu I., 8-9.iv.1992, AIK [16 mm]; (6, 8) females: (6) Saibai I., 22.ii.1994, TAL [20 mm], (8) Boigu I., 8-9.iv.1992, TAL [17 mm] (all TLIKC).



Figs 9-16. Sex brands of *Hypolycaena* spp. [width of brands in parentheses]. (9-12) *H. litoralis*: (9) Dauan I., 11.v.2001, AIK [2.0 mm]; (10) Dauan I., 1.v.2001, AIK [2.3 mm]; (11) Yam I., 11-12.vi.1992, AIK [3.4 mm]; (12) Boigu I., 9.iv.1992, TAL [3.3 mm]. (13-16) *H. phorbas*: (13) Bamaga, Qld, 15.iv.1995, TAL [4.2 mm]; (14) Saibai I., 10.iv.2001, AIK [6.0 mm]; (15) Kemp Beach, Yeppoon, Qld, 3-4.i.1979, TAL [5.2 mm]; (16) East Point, Darwin, NT, 28.iv-3.v.1993, AIK [5.2 mm].



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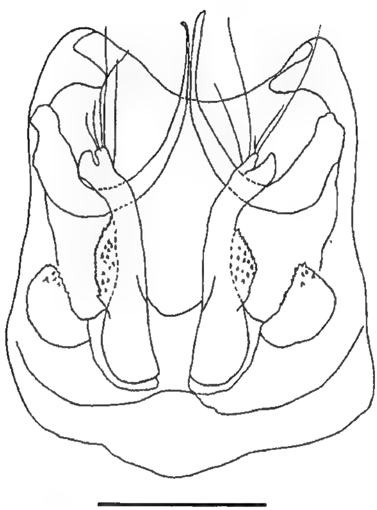

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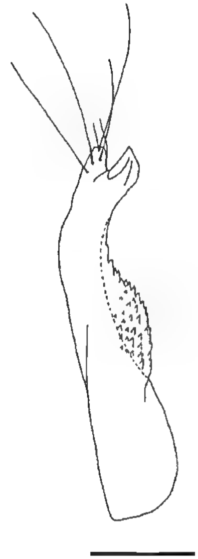

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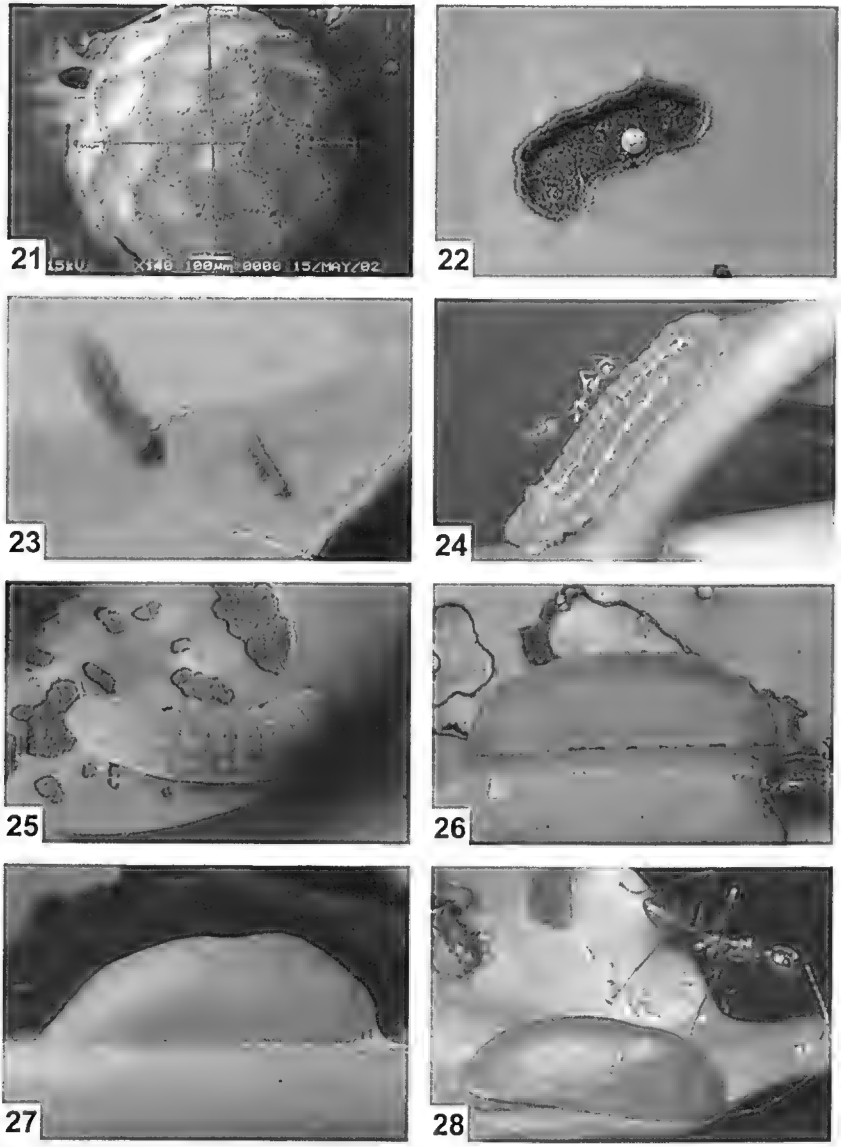
Figs 17-20. Male genitalia of *Hypolycaena* spp. with scale bar lengths. (17-18) *H. litoralis* (Holotype [VS 23]): (17) ventral view, 0.5 mm; (18) valva, 0.2 mm. (19-20) *H. phorbas* (Yeppoon, Qld, 12.v.1995, AIK): (19) ventral view, 0.5 mm; (20) valva, 0.2 mm.



Figs 21-28. *Hypolycaena litoralis*. (21) SEM image of egg [diameter 0.65 mm]; (22) egg in situ; (23) dorsal view of first instar larva, RHS larva [length 1.5 mm]; (24-25) final instar larvae: (24) dorsolateral view [16 mm] with attendant ant, *Oecophylla smaragdina*; (25) dorsal view [18 mm]; (26) prepupa, lateral view [13 mm]; (27-28) pupae: (27) lateral view [11 mm], (28) dorsolateral view [10 mm] with attendant ant.

Pupa (Figs 27-28). Length 11.8 mm [n=8]; smooth, slender, oblong; thoracic and abdominal dorsal humps slight; lime-green, including spiracles; no distinctive colour or surface features, *i.e.* without mottling or fine speckling.

Biology

The habitat of *H. litoralis* on Dauan Island (Fig. 33) consists of mangroves, predominantly *R. stylosa*, backing onto brackish areas where *Gymnanthera oblonga* (Burm. F.) P.S. Green (Asclepiadaceae) is a common component. These brackish areas are mixed with sparse vine thicket where *Premna serratifolia* L. (Lamiaceae) and *Pongamia pinnata* (L.) Pierre (Fabaceae) commonly grow. On all four islands, *H. litoralis* appears to be confined to these habitats where, in mangroves, its host plants *R. stylosa* and *Bruguiera* sp. (S.J. Johnson pers. comm.) and its attendant ant species occur. Females are most often seen flying around their host plant and, together with males, also fly along mangrove edges. Both sexes have a fast and direct flight, settle frequently and readily come to blossom. In April and May 2001, they were collected commonly from blossom of *P. serratifolia*. The environment and host plants of *H. litoralis* prompted our choice for its common name, Mangrove Flash.

Eggs of *H. litoralis* are deposited singly on the underside of mature leaves of *R. stylosa*, or in old larval leaf scars on the underside of mature leaves (Fig. 22). Young larvae were only found feeding on the terminal fresh growth and it is surmised that they travel to the terminal ends of the stems soon after hatching. In February 2004, the observed biology of *H. litoralis* was very similar to that of *H. phorbas* (Braby 2000), in that all larval and pupal stages were found together in close association with *O. smaragdina* in temporary ant shelters, at the terminal ends of the branches. The ants constructed these shelters by stitching the top four or five terminal leaves together in an upward direction (Fig. 32) and within these shelters the ants attended all stages of *H. litoralis*. In contrast, its biology appeared to be quite different to that of *H. phorbas* when observed in April and May 2002. There was no evidence of attendant ants constructing webbing or shelters around the larvae, with larvae most often found isolated from the ants or in the presence of only one or two. Furthermore, pupae were typically found singly on the underside edges of leaves toward the stems, with no ant attendance.

In general, immature stages were found on small *R. stylosa* plants (1-2 m high) as well as on larger trees (8 m high). Larval feeding causes the leaves of *R. stylosa* to twist and turn brown and this gives infested plants a scorched appearance (Fig. 31). Colonies of *H. litoralis* were isolated and localised within mangrove patches but, overall, they were easily located.

Discussion

In addition to the types of *H. litoralis* (see Appendices 1 and 2; 6 with male genitalia examined), the following comparative material was examined:

H. periphorbas - 7 ♂♂, 2 ♀♀ from mainland Papua New Guinea.

H. dictaea - 4 ♂♂, 2 ♀♀ from Normanby Island, 4 ♂♂, 1 ♀ from Woodlark Island; 1 ♂ from Misima Island; 3 ♂♂ (1 with genitalia examined) from mainland Papua New Guinea.

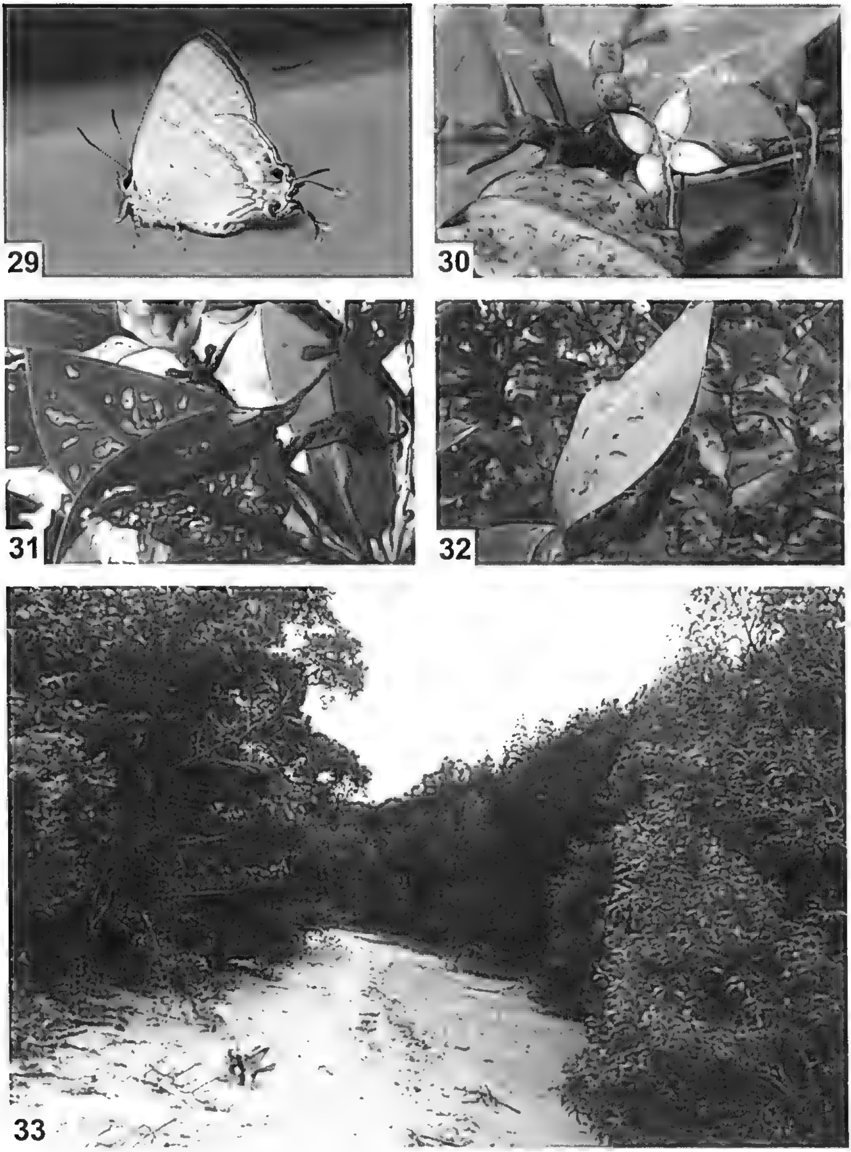
H. phorbas - 26 ♂♂, 25 ♀♀ (9 with male genitalia examined) from mainland Queensland; 38 ♂♂, 44 ♀♀ (6 with male genitalia examined) from Torres Strait; 39 ♂♂, 38 ♀♀ (3 male genitalia examined) from Northern Territory; 32 ♂♂, 14 ♀♀ from mainland Papua New Guinea.

Common features of both *Hypolycaena* groups that distinguish them from other related genera include: forewing with only 10 veins (*Rapala* Moore and *Deudorix* Hewitson have 11), with no radial branches (R_4 and R_5); eyes hirsute; hindwing with slender tails at the end of veins CuA_2 and 1A+2A and tornal lobes weakly developed (Parsons 1998, Braby 2000). In both sexes, adult *H. litoralis* are superficially similar to the other branded species from Papua New Guinea but appear closest to *H. phorbas*.

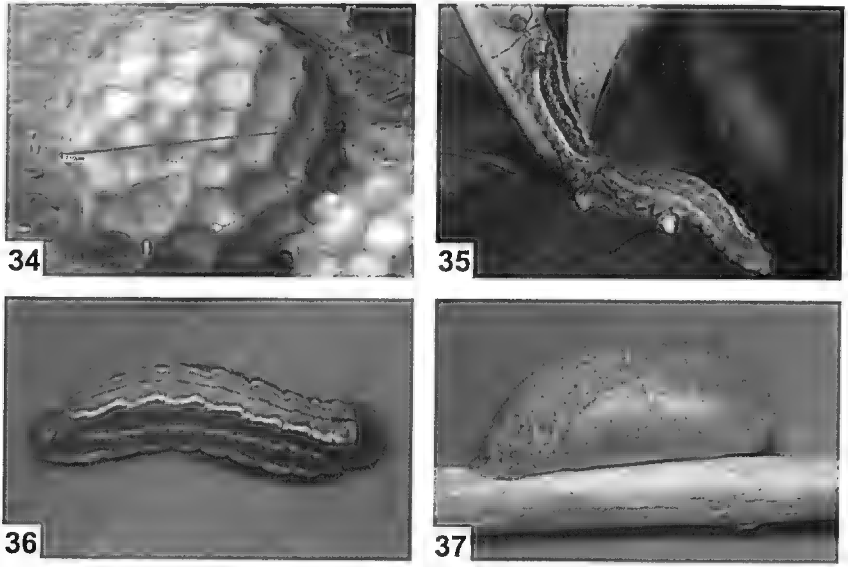
In Papua New Guinea *H. erylus* is restricted to the northwest coast and this possibly represents the eastern extremity for the species (Parsons 1998). *H. periphorbas* has been recorded only from the northeastern provinces (Parsons 1998). *H. erylus* and *H. periphorbas* have not been recorded from the Western, Gulf or Central Provinces, *i.e.* those provinces closest to Torres Strait where *H. litoralis* is known to occur. *H. dictaea* has been recorded from Central Province (Port Moresby) (Parsons 1998, Brandt Collection in ANIC). Males and females of these three species differ from *H. litoralis* in their size and in differences in wing colouring and pattern.

A small male of *H. dictaea* (forewing length 14 mm) in the Brandt Collection, labelled 'Port Moresby, Mt Lawes 1300 ft', superficially resembles the males of *H. litoralis* in size; however it differs by having the upperside ground colour dull purple with dull grey-black margins, a more rounded forewing apex and a less distinct sex brand radiating outwards along the forewing veins towards the termen. This specimen is also morphologically different from the other males of *H. dictaea* in the Brandt Collection and may represent a separate species.

Males of *H. litoralis* (Figs 1, 3) are smaller than males of *H. phorbas* (Figs 5, 7) (forewing lengths 13.14 mm [n=106] and 16.3 mm [n=103] respectively); the forewing upperside colour of male *H. litoralis* varies from deep blue-purple to blue but is most often deep blue-purple (94 of 106), rarely with white markings on the forewing in the area below the sex brand above vein 1A+2A (2 of 106) and the hindwing upperside is always deep blue-purple; the upperside of *H. phorbas* is never deep blue-purple and often has white forewing markings. The sex brand of *H. litoralis* is relatively small and variable in size and shape but never circular, rarely extending below vein CuA_2 (6 of 106) and most often overlaid with a line or a dusting of blue-purple forewing scales in the area between veins CuA_1 and CuA_2 (89 of 106)



Figs 29-33. (29) Newly emerged *Hypolycaena litoralis* female [forewing length 13 mm]; (30-32) *Rhizophora stylosa*: (30) flower [diameter 20 mm]; (31) old larval scarring [largest leaf 140 mm]; (32) larval shelter [100 mm]. (33) habitat of *H. litoralis* on Dauan I.



Figs 34-37. *Hypolycaena phorbas*. (34) SEM image of egg [diameter 0.75 mm], Darwin, NT; (35-36) final instar larvae: (35) lateral views of polymorphic forms, with attendant *Oecophylla smaragdina*, RHS larva [length 18 mm], Thursday I.; (36) dorsolateral view [17 mm], Dauan I. (37) lateral view of pupa [13 mm], Dauan I.

(Figs 9-12); in contrast, the sex brand of *H. phorbas* is consistently and relatively much larger, more circular in shape, always extending to some degree below vein CuA_2 and the area between veins CuA_1 and CuA_2 is never overlaid with forewing scales (Figs 13-16). Finally, the white subterminal lunules on the hindwing upperside of male *H. litoralis* are always poorly defined and sometimes absent (30 of 106) but, when present, rarely extend into the space above vein M_2 (14 of 106); in contrast, the white subterminal lunules of *H. phorbas* are always well defined and almost always extend into the space above vein M_2.

Parsons (1998) considered differences in the hindwing underside subtornal eyespots as characters that can be used to distinguish between adults of *H. erylus*, *H. dictaea* and *H. phorbas* in Papua New Guinea. Parsons (1998) noted that this eyespot was largest in *H. erylus*, intermediate in size in *H. dictaea* and smallest in *H. phorbas*. Furthermore, he noted that the orange area of the eyespot in *H. erylus* had a notably diffuse proximal margin that extended past veins CuA_1 and CuA_2; in *H. phorbas* it was diffuse at its margins and in *H. dictaea* it was rectangular in shape, bounded by veins CuA_1 and CuA_2 and clearly bordered with brown. In *H. litoralis* the size and extent of the orange area of the subtornal eyespot is variable but not

conspicuously rectangular in shape as in *H. dictaea* and, sometimes, the orange area crosses over vein CuA_1, a characteristic that is shared with *H. phorbas* from Australia. Therefore, the subtornal eyespot character is not useful in distinguishing *H. litoralis* from other 'branded' species of *Hypolycaena.*

Of the 'branded' PNG species of *Hypolycaena*, the male genitalia of *H. litoralis* are closest to those of *H. phorbas*; both differ from those of the other species in the shape of valvae and by the valvae possessing short and rounded basal lateral extensions (Figs 17-20). In *H. erylus* these extensions are longer, not projected laterally and their origin is not basal. They are not present in *H. periphorbas* and are long and narrow in *H. dictaea* (Parsons 1998). Parsons (1998) illustrated the male genitalia of the four 'branded' species but his illustrations of *H. phorbas* do not agree with our findings. In this study, we examined the male genitalia of 18 Australian specimens of *H. phorbas* and all had short and rounded basal lateral extensions on the valvae. Parsons' (1998) lateral and ventral illustrations of the genitalia of *H. phorbas* show them having long and narrow basal lateral extensions on the valvae, much like *H. dictaea*. Our conclusion is that his genitalia illustrations of *H. phorbas* are not correct and, considering the similarity of the lateral and ventral views to that of his illustration of *H. dictaea* and our examination of the genitalia of a specimen of *H. dictaea* from mainland Papua New Guinea, it is highly probable that his illustration of *H. phorbas* is actually of *H. dictaea*.

The male genitalia (Figs 17-20) of *H. litoralis* and *H. phorbas* are variable; however, in most cases they can be separated by the extent of the development of the ventro-lateral carina of the valva. In *H. litoralis* this carina is usually just slightly developed, whereas in *H. phorbas* it is well developed, with a strong serrate lamina often running the full length of the carina. Only one of six *H. litoralis* genitalia examined had a small lamina on the base of the ventro-lateral carina. Only one of 18 *H. phorbas* examined showed an apparent lack of a lamina, but a closer examination showed a very narrow lamina running the full length of the carina. Because of this variability, the holotype of *H. litoralis* (VS 23) was selected as the best example showing the slight development of the ventral-lateral carina of the valva. The genitalia of *H. litoralis* are also more delicate in structure and appearance than those of *H. phorbas*.

Female *H. litoralis* (Figs 2, 4) are also smaller than females of *H. phorbas* (Figs 6, 8) (forewing lengths: 13.67 mm [n=57] and 17.11 mm [n=107] respectively). In contrast to the female of *H. phorbas*, the brown-grey forewing upperside of female *H. litoralis* never has central white patches, but occasionally has small areas of white scales (6 of 57) and the white subterminal lunules on the hindwing upperside are always greatly reduced.

External morphological characters of the immature stages also assist in separating *H. litoralis* from *H. phorbas*. The egg surface structures of both

species are similar, in that both have patterns of reticulated pits and intervening ridges, but *H. litoralis* differs in having the tops of the ridges obtuse and granulated (Fig. 21), while in *H. phorbas* the tops are strongly acute and smooth (Fig. 34); the micropylar depression of the *H. litoralis* egg is smooth with no visible features, while that of *H. phorbas* is strongly ornate with a flowery pattern; the egg of *H. litoralis* is also smaller than that of *H. phorbas*. The mature larva of *H. litoralis* (Figs 24-25) is smaller and, in general, not as brightly coloured as that of *H. phorbas*; the dorsal and dorsolateral stripes of the *H. litoralis* larva are almost always obscured (but sometimes white), but are most often dull greenish-orange and pale green respectively, while the larva of *H. phorbas* has bright yellow and white dorsal stripes and bright greenish-white dorsolateral and lateral stripes (Fig. 36). *H. litoralis* larvae are not known to be polymorphic, while larvae of *H. phorbas* are known to have a number of forms, predominately green and red (Braby 2000) (Figs 35-36). The pupa of *H. litoralis* is smooth and slender, always lime green in colour with no distinctive colour or surface features and with only slight thoracic and abdominal dorsal humps (Figs 27-28); in contrast, the pupa of *H. phorbas* is stout with strongly outlined wing cases, is known to be polymorphic in colour (Parsons 1998, Braby 2000), has yellow spiracles and distinctive thoracic and abdominal dorsal humps (Fig. 37).

In general, apart from structures of the genitalia of the two species, *H. litoralis* can be distinguished from *H. phorbas* by its smaller size and the predominately deep blue-purple upperside of the male, although males are variable (Figs 1, 3), sometimes in the intensity of the colour (some have reflective blue scaling) and shape of the forewing, but most of all in the size and shape of the sex brand. Furthermore, male and female *H. litoralis* tend to be equal in size (forewing lengths: male - 13.14 mm [n=106], female - 13.67 mm [n=57]), as opposed to *H. phorbas*, in which females are larger than males (forewing lengths: male - 16.33 mm [n=103], female - 17.11 mm [n=107]). As a rule, both sexes of *H. litoralis* can be superficially identified by their small size, the deep blue-purple of the hindwing upperside (and most often the forewing) of the male, the absence of a white patch on the forewing upperside of the female and by their close association with mangroves.

To date, *H. litoralis* is known from only four islands in the northern and central parts of Torres Strait, Queensland. Of these, Saibai and Boigu are relatively large in size, flat and muddy with vegetation consisting predominately of mangroves, saltbush and other halophytic species. In contrast, Dauan and Yam Islands are volcanic in origin, have extensive monsoonal vine thickets and much smaller stands of mangroves than the former two islands. Considering the close proximity of Saibai and Boigu (approximately 2 and 3 km respectively) to the Western Province of Papua New Guinea, where large tracts of mangroves also occur, it is highly likely that *H. litoralis* also occurs there. Stands of mangroves and/or resident populations of *O. smaragdina* are known from other Torres Strait islands,

for example to the south and southeast of Saibai Island (south - Zagai and Sassie close to Yam; southeast - Stephens, Aukane, Rennel and Kabbikane) (De Baar 1988 and pers. comm., T.A. Lambkin pers. obs.) and it is possible that the distribution of *H. litoralis* in Australia might be more extensive than is currently known. Braby (2000) provided a useful map of this region, showing the relative positions of all Torres Strait islands discussed.

Acknowledgements

We thank the local community councils of Saibai, Yam, Boigu and Dauan Islands for allowing entry into their communities, supplying lodging and providing much cooperation during the time spent on their islands. We also acknowledge the following: M. De Baar and S.J. Johnson provided valuable personal communications; botanical identifications were made by B. Wilson (Queensland Herbarium); J.W. d'Apice, S.J. Johnson, C.G. Miller and P.S. Valentine allowed examination of material held in their collections; E.D. Edwards provided valuable advice on type specimens and kindly allowed access to literature and specimens held in the ANIC; P.R. Ackery provided advice on specimens held in The Natural History Museum, London; J.S. Bartlett gave valuable support in the formatting and preparation of the colour plates and E. Hayward of Charles Darwin University, Darwin, provided the SEM images of *Hypolycaena* eggs.

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Appendix 1. Collection and external character data for types of male *Hypolycaena litoralis* sp. n., voucher specimens 1-106, used for description of species.

No. = Voucher specimen number; **A** = Forewing length (mm); **B** = Forewing scales across sex brand; **C** = Sex brand extending below vein CuA_2; **D** = Blue-purple forewing; **E** = Hindwing subterminal lunules present; **F** = Hindwing subterminal lunules above vein M_2. Y = yes; N = no. Holotype = No. 23.

No.	Collection data		A	B	C	D	E	F
1	Dauan	11.v.2001	14	Y	N	Y	Y	N
2	Yam	11-12.vi.1992	14	Y	N	Y	N	N
3	Dauan	9.v.2001	14	Y	N	Y	N	N
4	Dauan	9.v.2001	13	Y	N	Y	Y	N
5	Dauan	11.v.2001	13	Y	N	Y	Y	N
6	Dauan	1.v.2001	13	Y	N	Y	Y	N
7	Dauan	11.v.2001	13	Y	N	Y	N	N
8	Yam	11-12.vi.1992	15	N	N	N	Y	N
9	Boigu	9.iv.1992	15	Y	N	Y	Y	N
10	Dauan	9.v.2001	13	Y	N	Y	Y	N
11	Dauan	9.v.2001	13	Y	N	Y	Y	N
12	Dauan	11.v.2001	14	Y	N	Y	N	N
13	Dauan	1.v.2001	14	Y	N	Y	Y	N
14	Yam	11-12.vi.1992	15	Y	N	Y	Y	N
15	Dauan	1.v.2001	13	Y	N	Y	Y	N
16	Dauan	11.v.2001	14	Y	N	Y	Y	N
17	Dauan	13.v.2001	14	Y	N	Y	Y	N
18	Dauan	9.v.2001	13	Y	N	Y	Y	N
19	Dauan	9.v.2001	13	Y	N	Y	N	N
20	Dauan	13.v.2001	13	Y	N	Y	Y	N
21	Dauan	9.v.2001	14	Y	N	Y	Y	N
22	Saibai	9.v.2001	12	Y	N	Y	Y	N
23	Boigu	8-9.iv.1992	14	Y	N	Y	Y	N
24	Yam	11-12.vi.1992	12	N	Y	Y	Y	N
25	Boigu	8-9.iv.1992	12	N	N	Y	Y	N
26	Dauan	10.v.2001	13	Y	N	Y	N	N
27	Dauan	27.iv.2000	12	Y	N	Y	Y	N
28	Dauan	9.v.2001	14	Y	N	Y	Y	N
29	Dauan	13.v.2001	13	Y	N	Y	Y	N
30	Boigu	8-9.iv.1992	14	Y	N	Y	Y	N
31	Dauan	11.iv.2001	14	Y	N	Y	Y	N
32	Yam	11-12.vi.1992	14	N	N	Y	N	N
33	Yam	12.vi.1992	14	N	Y	N	N	N
34	Dauan	4.iv.1990	12	Y	N	Y	N	N
35	Saibai	22.iii.1994	14	Y	N	N	Y	N
36	Yam	12.vi.1992	12	Y	N	Y	N	N
37	Yam	12.vi.1992	14	Y	Y	Y	N	N
38	Saibai	27.ix.1992	12	Y	N	N	Y	N
39	Yam	3.iv.1984	13	N	Y	Y	Y	N
40	Yam	3.iv.1984	14	Y	N	Y	Y	N
41	Yam	11-12.vi.1992	14	Y	N	Y	N	N
42	Yam	12.vi.1992	13	N	N	Y	N	N
43	Dauan	13 – 18.iv.2001	13	Y	N	Y	Y	Y

No.	Collection data		A	B	C	D	E	F
44	Dauan	26.iv – 2.v.2002	13	N	N	Y	Y	N
45	Dauan	26.iv – 2.v.2002	12	Y	N	Y	Y	Y
46	Dauan	26.iv – 2.v.2002	13	Y	Y	Y	Y	N
47	Dauan	26.iv – 2.v.2002	12	Y	N	Y	Y	N
48	Dauan	26.iv – 2.v.2002	12	Y	N	Y	Y	N
49	Dauan	26.iv – 2.v.2002	13	Y	N	Y	N	N
50	Dauan	26.iv – 2.v.2002	12	Y	N	Y	Y	N
51	Dauan	26.iv – 2.v.2002	14	Y	N	Y	Y	N
52	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
53	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
54	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
55	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
56	Dauan	26.iv – 2.v.2002	13	N	N	Y	N	N
57	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
58	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	Y
59	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
60	Dauan	26.iv – 2.v.2002	13	N	N	Y	Y	N
61	Saibai	03 – 04.v.2002	13	N	N	Y	Y	Y
62	Saibai	03 – 04.v.2002	13	N	N	Y	N	N
63	Dauan	13 – 18.iv.2001	12	Y	N	Y	Y	N
64	Saibai	19 – 20.iv.2001	13	N	N	Y	Y	N
65	Dauan	26.iv – 2.v.2002	12	Y	N	Y	Y	N
66	Dauan	26.iv – 2.v.2002	13	N	N	Y	Y	Y
67	Dauan	26.iv – 2.v.2002	13	Y	N	Y	N	N
68	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
69	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
70	Dauan	26.iv – 2.v.2002	13	Y	N	Y	Y	N
71	Dauan	26.iv – 2.v.2002	13	N	N	Y	N	N
72	Saibai	25.iv.2002	13	N	N	Y	Y	N
73	Dauan	Emg: 05.v.2002	13	Y	N	Y	Y	Y
74	Dauan	Emg: 12.v.2002	13	Y	N	Y	Y	N
75	Dauan	Emg: 14.v.2002	13	Y	N	Y	Y	N
76	Dauan	Emg: 16.v.2002	12	Y	N	N	N	N
77	Dauan	Emg: 12.v.2002	12	Y	N	N	Y	Y
78	Dauan	Emg: 18.v.2002	13	Y	N	N	Y	N
79	Dauan	26.iv – 2.v.2002, em 04.v.2002	13	Y	N	Y	Y	Y
80	Dauan	26.iv – 2.v.2002, em 04.v.2002	13	Y	Y	Y*	Y	Y
81	Dauan	26.iv – 2.v.2002	12	Y	N	Y	N	N
82	Dauan	26.iv – 2.v.2002	12	Y	N	Y	N	N
83	Dauan	26.iv – 2.v.2002, em 04.v.2002	13	Y	N	Y	N	N
84	Dauan	26.iv – 2.v.2002, em 05.v.2002	14	Y	N	Y*	Y	N
85	Dauan	26.iv – 2.v.2002, em 05.v.2002	13	Y	N	Y	N	N
86	Dauan	pupa coll 17.ii.2004	14	Y	N	Y	Y	N
87	Dauan	pupa coll 17.ii.2004	14	Y	N	Y	Y	N
88	Yam	3.iv.1984	13	N	N	Y	Y	N
89	Yam	3.iv.1984	14	Y	N	Y	N	N

No.	Collection data		A	B	C	D	E	F
90	Dauan	13.iv.1994	14	Y	N	Y	Y	N
91	Dauan	4.iv.2004	13	Y	N	Y	N	N
92	Dauan	9.iv.2004	13	Y	N	Y	Y	N
93	Dauan	9.iv.2004	13	Y	N	Y	Y	Y
94	Dauan	12.iv.2004	12	Y	N	Y	N	N
95	Dauan	12.iv.2004	14	Y	N	Y	Y	Y
96	Dauan	12.iv.2004	12	Y	N	Y	Y	Y
97	Dauan	12.iv.2004	13	Y	N	Y	Y	Y
98	Dauan	em. 16.iv.2004	13	Y	N	Y	N	N
99	Dauan	10.iv.2004	13	Y	N	Y	Y	N
100	Dauan	10.iv.2004	13	Y	N	Y	N	N
101	Dauan	em. 14.iv.2004	12	Y	N	Y	N	N
102	Dauan	em. 18.iv.2004	13	Y	N	Y	Y	N
103	Dauan	em. 19.iv.2004	14	Y	N	Y	Y	N
104	Dauan	em. 19.iv.2004	14	Y	N	Y	N	N
105	Dauan	em. 19.iv.2004	13	Y	N	Y	Y	N
106	Dauan	em. 22.iv.2004	15	Y	N	Y	Y	Y

* = white scales on forewing.

Appendix 2. Collection and external character data for types of female *Hypolycaena litoralis* sp. n., voucher specimens 1-57, used for description of species. Y = yes; N = no.

Voucher specimen No.	Collection data		Forewing length (mm)	Forewing with white scales
1	Dauan	12.v.2001	15	N
2	Dauan	9.v.2001	14	N
3	Dauan	9.v.2001	15	N
4	Dauan	11.v.2001	14	N
5	Dauan	9.v.2001	14	N
6	Dauan	11.v.2001	13	N
7	Dauan	9.v.2001	14	N
8	Dauan	13.v.2001	14	N
9	Dauan	9.v.2001	14	N
10	Dauan	9.v.2001	13	N
11	Dauan	9.v.2001	14	Y
12	Dauan	9.v.2001	15	Y
13	Dauan	13.v.2001	14	N
14	Dauan	9.v.2001	13	N
15	Boigu	21.iii.1994	15	N
16	Boigu	21.iii.1994	13	N
17	Dauan	13 – 18.iv.2001	15	Y
18	Dauan	26.iv – 2.v.2002	14	N
19	Dauan	26.iv – 2.v.2002	14	N
20	Dauan	26.iv – 2.v.2002	14	Y
21	Dauan	26.iv – 2.v.2002	14	N
22	Dauan	26.iv – 2.v.2002	14	N
23	Dauan	26.iv – 2.v.2002	14	N
24	Dauan	26.iv – 2.v.2002	13	N

Voucher specimen No.	Collection data		Forewing length (mm)	Forewing with white scales
25	Dauan	Emg: 05.v.2002	14	N
26	Dauan	13 – 18.iv.2001	14	N
27	Saibai	19 – 20.iv.2001	14	N
28	Saibai	19 – 20.iv.2001	15	N
29	Dauan	26.iv – 2.v.2002	13	N
30	Dauan	26.iv – 2.v.2002	14	N
31	Dauan	26.iv – 2.v.2002	14	N
32	Dauan	26.iv – 2.v.2002	13	N
33	Dauan	Emg: 03.v.2002	14	N
34	Dauan	Emg: 10.vi.2002	14	Y
35	Dauan	Emg: 07.vii.2002	13	Y
36	Dauan	26.iv – 2.v.2002, em 03.v.2002	13	N
37	Dauan	26.iv – 2.v.2002, em 03.v.2002	14	N
38	Dauan	26.iv – 2.v.2002, em 03.v.2002	12	N
39	Dauan	26.iv – 2.v.2002, em 04.v.2002	12	N
40	Dauan	26.iv – 2.v.2002, em 05.v.2002	14	N
41	Dauan	26.iv – 2.v.2002	13	N
42	Boigu	12.iv.1992	13	N
43	Saibai	27.ii.2004	14	N
44	Dauan	12.iv.2004	12	N
45	Dauan	em. 12.iv.2004	13	N
46	Dauan	em. 12.iv.2004	14	N
47	Dauan	em. 13.iv.2004	13	N
48	Dauan	em. 14.iv.2004	12	N
49	Dauan	em. 23.iv.2004	14	N
50	Dauan	10.iv.2004	14	N
51	Dauan	em. 12.iv.2004	13	N
52	Dauan	em. 14.iv.2004	14	N
53	Dauan	em. 14.iv.2004	13	N
54	Dauan	em. 18.iv.2004	15	N
55	Dauan	em. 18.iv.2004	13	N
56	Dauan	em. 18.iv.2004	13	N
57	Dauan	em. 20.iv.2004	13	N

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HERBIVOROUS INSECTS ASSOCIATED WITH THE PAPERBARK *MELALEUCA QUINQUENERVIA* AND ITS ALLIES: VI. PERGIDAE (HYMENOPTERA)

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Abstract

Surveys were conducted in Australia to find biological control agents for the broad-leaved paperbark tree, *Melaleuca quinquenervia*, a serious pest in Florida, USA. This paper presents collection records and biological information for five sawfly species: *Acanthoperga cameronii* (Westwood), *Perga vollenhovii* Westwood, *Pergagrapta polita* Leach, *Pterygophorus insignis* Kirby and *Lophyrotoma zonalis* (Rohwer); all in family Pergidae. One of these species, *Lophyrotoma zonalis*, was extensively studied as a biological control agent but concerns over its toxicity have delayed release.

Introduction

Melaleuca quinquenervia (Cav.) S.T. Blake, the Australian broad-leaved paperbark tree, has become a serious pest in southern Florida, causing extensive economic and environmental damage. A history of surveys to find biological control agents for this tree and an overview of why it has become a serious pest in Florida are outlined in Rayamajhi *et al.* (2002). In five previous articles (Balciunas *et al.* 1993a, 1993b, 1995, Burrows *et al.* 1994, 1996), extensive collection and rearing records were presented for species of Lepidoptera belonging to the Noctuoidea, Geometridae, Gelechioidea, Tortricidae and Pyralidae and also limited records for other lepidopteran families. This paper continues the series and outlines the collection and rearing records of all species of Pergidae (Hymenoptera) found on broad-leaved *Melaleuca* species, as well as field observations and notes on the biology of each pergid species.

Methods

Collection methods were described in Balciunas *et al.* (1993a). All Pergidae recorded in this paper were collected and reared between 1987 and 2003. Observations on the biology and habits were made both in the field and laboratory. All larvae were reared on foliage of the tree species on which they were collected. Larvae of species of Perginae were placed into sealed plastic containers lined with paper towelling. Young foliage was provided as needed. When larvae became late instars, moist sand up to 5 cm deep was placed in the bottom of the container for pupation. Similar containers were used for Pterygophorinae species; however larvae were provided with older leaves while paper towelling or bark up to 5 cm deep was provided for pupation. The adult sawflies were identified by Dr Ian Naumann and Dr Stefan Schmidt (both formerly CSIRO Entomology) and Dr David Smith from the United States Department of Agriculture.

Voucher specimens are held at the Australian Biological Control Laboratory (ABCL), Brisbane, the Australian National Insect Collection (ANIC), Canberra and the United States Department of Agriculture (USDA), Systematic Entomology Laboratory, Washington D.C.

Collecting was concentrated in two coastal areas: from the Daintree River (north of Cairns) to Townsville in northern Queensland and from Hervey Bay in southern Queensland to Coffs Harbour in northern New South Wales. We also occasionally sampled sites outside these areas in Qld, NSW and the Northern Territory. The sites referred to in the text are listed below. Those marked with an asterisk (*) are either ornamental plantings or forest remnants in urban areas.

Northern Queensland: **Centenary Park***, Cairns (16°54.2'S 145°44.8'E) and **Cooktown Botanical Gardens*** (15°28.3'S 145°15.5'E).

Southern Queensland: **Boondall**, Brisbane (27°20.7'S 153°04.0'E); **Bracken Ridge**, Brisbane (27°20.0'S 153°01.9'E); **Bribie Island**, 49 km N of Brisbane (27°02.4'S 153°08.1'E); **Bribie Island Road**, 45 km N of Brisbane (27°04.6'S 153°00.6'E); **Bribie Island Tigers Club**, 45.8 km N of Brisbane (27°04.8'S 153°10.5'E); **Burpengary**, 34 km N of Brisbane (27°09.5'S 152°58.4'E); **Chelmer***, Brisbane (27°31.0'S 152°58.3'E); **Coolum**, 100 km N of Brisbane (26°34.1'S 153°05.5'E); **Deagon Deviation***, Brisbane (27°19.5'S 153°03.1'E); **Dickman Road***, 21 km S of Brisbane (27°39.5'S 152°59.8'E); **Ernest**, 62 km SE of Brisbane (27°04.6'S 153°00.6'E); **Fitzgibbon**, Brisbane (27°20.1'S 153°01.8'E); **Greenbank***, 26.5 km S of Brisbane (27°42.5'S 153°00.1'E); **Gumdale**, Brisbane (23°30.3'S 153°01.8'E); **Indooroopilly***, Brisbane (27°30.7'S 152°59.8'E); **Landsborough**, 74 km NNW of Brisbane (26°48.3'S 152°58.7'E); **Logan Sewerage Works***, 29 km SE of Brisbane (27°41.1'S 153°11.7'E); **Maroochydore Airport**, 95 km N of Brisbane (26°36.7'S 153°05.6'E); **Mountain Creek**, 85 km N of Brisbane (26°42.3'S 153°06.0'E); **Morayfield**, 45 km NNW of Brisbane (27°07.3'S 152°58.5'E); **North Pine Dam***, 29 km N of Brisbane (27°16.1'S 152°56.5'E); **Nudgee Nature Reserve**, 12.6 km NNE Brisbane (27°22.6'S 153°05.6'E); **Peregian Environmental Park**, 107 km N of Brisbane (26°30.4'S 153°05.5'E); **Poona National Park**, 212 km NNW of Brisbane (25°34.8'S 152°46.4'E); **Roy's Road**, 70 km N of Brisbane (26°51.1'S 152°59.4'E); **Sunnybank***, Brisbane (27°34.5'S 153°04.1'E); **Tibrogargen**, 60 km NNW of Brisbane (26°55.79'S 152°57.31'E) and **Woongoolba**, 42 km ESE of Brisbane (27°42.8'S 153°21.2'E).

New South Wales: **Queens Lake Nature Reserve**, 10 km SSW of Port Macquarie (31°37.8'S 152°49.6'E); **Lennox Head**, 123 km NNE of Grafton (28°44.8'S 153°35.8'E); **Maclean**, 39 km NE of Grafton (29°26.8'S 153°13.8'E); **Perch Hole**, 14 km SSW of Port Macquarie (31°29.8'S 152°54.1'E); **Sandy Beach**, 57 km SE of Grafton (30°09.4 153°11.5); **Tyagarah**, 136 km NNE Grafton (28°35.5'S 153°32.4'E); **Wamberal Lagoon Reserve**, 57 km N of Sydney (33°24.5'S 151°27.7'E); **White Tree Bay**, Myall Lakes (32°31.7'S 152°59.8'E); **Woodburn**, 62 km NE of Grafton (29°13.2'S 153°15.4'E) and **Yamba***, 50 km NE of Grafton (29°26.2'S 153°21.5'E).

Northern Territory: **Darwin City*** (12°27.7'S 130°50.4'E) and **East Charlotte River**, approx. 30 km S of Darwin (12°43'S 130°49'E).

Results

Collection and rearing records for all species of Pergidae collected in surveys of *Melaleuca* species are given in Table 1. The distribution of *Lophyrotoma zonalis* (Rohwer) and details of its biology and host range were detailed by Burrows and Balciunas (1997). Only new collection records for this species are listed.

Table 1. Pergidae sawflies reared from *Melaleuca quinquenervia* and six other myrtaceous tree species. Mlb = *M. leucadendra*, Mnd = *M. nodosa*, Mqn = *M. quinquenervia*, Mvr = *M. viridiflora*.

Species and Collection Site	Host Plant	Stage and No. Collected	Date Collected	Life History Information Pp = prepupal/pupal period
		Subfamily Perginae (all species feed on young leaves)		
Acanthoperga cameronii				
Fitzgibbon	Mqn	30 larvae	28.vi.89	Preserved
Bracken Ridge	Mqn	19 larvae	5.vii.89	27 adults emerged 23.viii.-24.viii.89, pp=28-29 d
Bribie Island	Mqn	17 larvae	18.vii.89	7 adults emerged 16.x.-26.x.89
Tibrogargen	Mqn	14 larvae	18.vii.89	9 adults emerged 10.x.-26.x.89, pp=35-51 d
Gumdale	Mqn	No data	26.vii.89	No data
Gumdale	Mqn	12 larvae	5.ix.89	Died as immatures
Deagon Deviation	Mqn	No data	5.ix.89	No data
North Pine Dam	Mqn	28 larvae	9.xi.89	3 adults emerged 4-30.i.90, pp=30-56 d
Burpengary	Mqn	11 larvae	9.xi.89	Died as immatures
Greenbank	Mqn	15 larvae	10.xi.89	4 adults emerged 23.xii.89-2.i.90, pp 28-38 d
Burpengary	Mqn	10 larvae	20.xi.89	Died as immatures
Lennox Head	Mqn	35 larvae	20.iii.90	Died as immatures
Burpengary	Mqn	10 larvae	20.v.90	3 adults emerged
Fitzgibbon	Mqn	21 larvae	30.v.90	6 adults emerged 19-28.viii.90, pp=58-67 d
Burpengary	Mqn	19 larvae	1.viii.90	11 adults emerged 11-17.ix.90, pp=28-35 d
Boondall	Mqn	5 larvae	7.xi.90	2 adults emerged 12-14.xii.90, pp=30-32 d
Landsborough	Mqn	10 larvae	7.xi.90	No data
Ernest	Mqn	18 larvae	4.vi.91	Died as immatures
Morayfield	Mqn	14 larvae	29.x.92	9 adults emerged 17.xii.92-11.i.93, pp=18-43 d
Morayfield	Mqn	14 larvae	19.iv.93	Died as immatures
Morayfield	Mqn	1 larva	31.v.93	Died as immature
Morayfield	Mqn	30 larvae	21.vi.93	Died as immatures
Morayfield	Mqn	20 larvae	1.vii.93	Died as immature

Species and Collection Site	Host Plant	Stage and No. Collected	Date Collected	Life History Information Pp = prepupal/pupal period
Acanthoperga cameronii (continued)				
Morayfield	Mqn	22 larvae	26.vii.93	Adult emerged 4.ix.93
Morayfield	Mqn	13 larvae	2.viii.93	6 adults emerged 3.ix.-24.xii.93
Logan Sewerage Works	Mqn	18 larvae	1997	18 adults emerged
Roy's Road	Mqn	No data	1997	8 adults emerged
Maroochydore Airport	Mqn	5 larvae	1997	4 adults emerged
Maroochydore Airport	Mqn	27 larvae	2.vii.98	22 adults emerged 29.viii.-14.ix.98
Morayfield	Mqn	No data	15.vii.98	No data
Fitzgibbon	Mqn	No data	20.vii.98	No data
Coolum	Mqn	6 larvae	28.vii.98	6 adults emerged
Dickman Road	Mqn	Larvae, no data	17.xii.98	No data
Peregian Environmental Park	Mqn	30 larvae	10.viii.00	Died in rearing
Queens Lake Nature Reserve	Mqn	25 larvae	1.xi.00	5 adults emerged
Perch Hole	Mqn	Larvae, no data	1.viii.01	7 adults emerged 20-24.ix.01
Roy's Road	Mqn	15 larvae	5.xi.02	No data
Perga vollenhovii				
Centenary Park	Mlb	50 larvae	13.vii.87	Adult emerged
Centenary Park	Mlb	24 larvae	3.viii.87	15 adults emerged 6.ix.-14.ix.87
Centenary Park	Mlb	114 larvae	29.vii.88	14 adults emerged 5.ix.-8.ix.88
Cooktown Botanical Gardens	Mlb	30 larvae	27.viii.88	No data
Centenary Park	Mlb	9 larvae	10.vii.89	No data
Pergagrapta polita				
Sunnybank	Mqn	1 larva	5.x.87	Preserved
Tibrogargen	Mqn	24 larvae	7.vi.88	4 adults emerged 25.x.-27.x.88
Sandy Beach	Mqn	14 larvae	18.viii.88	3 adults emerged 1.xi.88
Bribie Island Road	Mqn	60 larvae	19.viii.88	34 adults emerged 20.x.-14.xi.88, pp=58-83 d
Bracken Ridge	Mqn	11 larvae	19.viii.88	11 adults emerged 7.xi.88-12.i.89, pp=37-102 d
Gumdale	Mqn	60 larvae	26.vii.89	8 adults emerged 23.x.-2.xi.89
Gumdale	Mqn	12 larvae	5.ix.89	Adult emerged 27.iii.90, pp=198 d
Fitzgibbon	Mqn	23 larvae	30.v.90	Died as immatures

Species and Collection Site	Host Plant	Stage and No. Collected	Date Collected	Life History Information Pp = prepupal/pupal period
Pergagrapta polita (continued)				
Deagon Deviation	Mqn	6 larvae	6.vi.90	2 adults emerged 28.iii.91, pp=231 d
Gumdale	Mqn	18 larvae	1.viii.90	Died as immatures
Yamba	Mqn	11 larvae	11.ix.90	10 adults emerged 19-23.x.90, pp=24-28 d
Lennox Head	Mqn	8 larvae	11.ix.90	Died as immatures
Boondall	Mqn	10 larvae	15.vii.92	7 adults emerged 8.iii.93
Lennox Head	Mqn	8 larvae	3.viii.00	Adult emerged 5-6.x.00
Mountain Creek	Mqn	200 larvae	10.viii.00	8 adults emerged 16-27.x.00
Mountain Creek	Mqn	Larvae, no data	9.x.00	No data
Subfamily Pterygophorinae (both species feed on leaves)				
Pterygophorus insignis				
Maclean	Mqn	1 larva	15.iii.88	Preserved
North Pine Dam	Mqn	24 larvae	15.xi.88	Preserved
Indooroopilly	Mqn	29 larvae	2.i.90	Died as immatures
Burpengary	Mqn	19 larvae	3.i.90	Died as immatures
Fitzgibbon	Mqn	10 larvae	3.i.90	Died as immatures
Burpengary	Mqn	14 larvae	23.i.90	Adult male emerged 16.iii.90
Fitzgibbon	Mqn	13 larvae	23.i.90	Died as immatures
Lennox Head	Mqn	17 eggs	20.iii.90	Died as immatures
Coolum	Mqn	95 larvae	1.v.90	7 adults emerged 25.vii.90-23.i.91 pp=69 d [1 individual only]
Fitzgibbon	Mqn	42 larvae	10.v.90	Died as immatures
Fitzgibbon	Mqn	2 larvae	20.v.90	2 adults emerged 27-28.viii.90, pp= 80-81 d
Fitzgibbon	Mqn	1 larva	30.v.90	Died as immature
Indooroopilly	Mqn	23 larvae	10.v.91	2 adults emerged 6.ix.-14.x.91
Ernest	Mqn	2 larvae	4.vi.91	Died as immatures
Chelmer	Mqn	1 larva	29.vii.91	No data
Indooroopilly	Mnd	10 larvae	13.ii.92	2 adults emerged
Indooroopilly	Mqn	Adult	15.iv.92	Preserved
Fitzgibbon	Mqn	20 larvae	26.v.92	3 adults emerged 17.vii.-10.viii.92, pp=16-40 d
Chelmer	Mqn	12 larvae	31.v.92	Died as immatures
Coolum	Mqn	6 larvae	22.vi.92	4 adults emerged 5.viii.-10.viii.92, pp=13-17 d
Chelmer	Mqn	1 larva	1.vii.92	Adult emerged 17.viii.92, pp=66 d
Indooroopilly	Mqn	1 larva	17.xii.92	Died as immature
Morayfield	Mqn	35 larvae	20.i.93	Died as immatures

Species and Collection Site	Host Plant	Stage and No. Collected	Date Collected	Life History Information Pp = prepupal/pupal period
Pterygophorus insignis (continued)				
Indooroopilly	Mqn	16 larvae	8.ii.93	5 adults emerged
Coolum	Mqn	15 larvae	31.iii.93	Died as immatures
Indooroopilly	Mqn	14 larvae	1.iv.93	Died as immatures
Morayfield	Mqn	1 larva	29.iv.93	Died as immature
Morayfield	Mqn	1 larva	6.v.93	Died as immature
Indooroopilly	Mqn	8 larvae	14.xii.93	Died as immatures
Coolum	Mqn	7 larvae	7.iii.94	Died as immatures
Morayfield	Mqn	No data	27.vii.95	Field observation
Woodburn	Mqn	1 larva	8.iv.97	Adult emerged
Logan Sewerage Works	Mqn	1 larva	19.v.97	Adult emerged
Tayagarah	Mqn	2 larva	xii.97	2 adults emerged
Wamberal Lagoon Reserve	Mqn	22 larvae	14.x.99	Died as immatures
Woongoolba	Mqn	3 larvae	16.xii.99	Adult emerged
Roy's Road	Mqn	11 larvae	30.iii.00	Died as immatures
Peregian Environmental Park	Mqn	11 larvae	30.iii.00	Died as immatures
Roy's Road	Mqn	7 larvae	19.iv.00	5 died as immatures, 2 preserved
Roy's Road	Mqn	1 larva	16.vi.00	Preserved
White Tree Bay	Mqn	20 larvae	31.x.00	Preserved
Poona National Park	Mqn	7 larvae	5.xii.00	Died in rearing
Indooroopilly	Mqn	Larvae, no data	3.v.01	Adult emerged
Nudgee Nature Reserve	Mqn	15 larvae	31.i.02	5 adults emerged
Poona National Park	Mqn	5 larvae	30.v.02	Adult emerged 6.viii.02
Lophyrotoma zonalis				
Darwin	Mlb	30 larvae	19.iv.93	6 adults emerged 19-24.v.93
East Charlotte River	Mvr	17 larvae	11.xi.98	Died as immatures
Bribie Island Tigers Club	Mlb	53 larvae	4.iii.04	50 died in rearing, 3 preserved
Bribie Island Tigers Club	Mlb	9 adults	1.iv.04	Preserved

Discussion

Pest status

Of the five sawfly species collected by ABCL staff from broad-leaved *Melaleuca* species in Queensland, New South Wales and the Northern Territory, only two species have been recorded elsewhere as a pest of *Melaleuca*. Jones and Elliot (1990) listed a paperbark sawfly species in tropical and subtropical regions of Australia that attacked *M. leucadendra*, *M. quinquenervia* and *M. viridiflora*. It was listed as a gregarious species that riddled the papery bark with holes. Although the species was not identified, it is likely to be *Lophyrotoma zonalis*, the only species which pupates by

burrowing into the soft, papery bark of broad-leaved *Melaleuca* trees. *Pterygophorus insignis* Kirby, also known as the long-tailed sawfly, is a very destructive pest of *Callistemon* and also feeds on *Leptospermum* spp. and *Melaleuca armillaris* Smith (Jones and Elliott 1990).

Distribution and host plants

Our records for *L. zonalis* now include Bribie Island in southeast Queensland. Burrows and Balciunas (1997) listed Mackay, on the central Queensland coast, as the southernmost range of this species. Its appearance on Bribie Island, 900 km south of Mackay, appears to be isolated as no other infestations in this region have been observed in over 17 years of collections. We suspect an introduction into this area from its normal range has occurred, possibly via the nursery trade. We also collected *L. zonalis* from two locations in the Northern Territory: Darwin and the East Charlotte River. Burrows and Balciunas (1997) listed only literature records and no collections from this region. *Acanthoperga cameronii* (Westwood), *Pergagrapta polita* Leach and *Pterygophorus insignis* were only collected in southeast Queensland and New South Wales, while *Perga vollenhovii* Westwood was restricted to the tropical region between Cairns and Cooktown, although it has been recorded as far south as New South Wales (Benson 1939). *Acanthoperga cameronii* (Westwood) appears to be highly specific and was only collected from *M. quinquenervia*, while *Perga vollenhovii* was only recorded on *M. leucadendra*. We collected *Pergagrapta polita* from *M. quinquenervia*, although it is known to have many *Eucalyptus* and *Angophora* hosts (S. Schmidt pers. comm.). *Pterygophorus insignis* larvae were collected from *M. quinquenervia* and *M. nodosa* (Gaertn.) Smith in southeast Queensland.

Biology

Acanthoperga cameronii was the only species (excluding *L. zonalis*) that oviposited on potted saplings in the laboratory. Parthenogenesis was observed, with the female ovipositing 29 eggs into young plant tissue along the midvein on one side of a leaf. All eggs hatched together after 12 days and the neonate larvae formed a circular, gregarious feeding group on the young leaf. As they became larger, the larvae fed as a front along both sides of the young leaves. The larval duration for these laboratory generated immatures was 48 days (n=27) and the prepupal/pupal duration ranged from 48-135 days (n=7).

The habits and biology of immatures of both *A. cameronii* and *Pergagrapta polita* are very similar. Feeding occurs at night and only on young foliage. During the day larvae move away from this foliage to a lower twig or branch (aggregation sites), forming a gregarious mass. Hundreds of larvae have been observed in these groups, which often varied in age structure. Damage is distinctive at field sites where the tops of trees are completely defoliated. When larvae are disturbed, they raise their head and abdomen and regurgitate

plant host oils as a defence mechanism. Regurgitation may also be used to eliminate oils from their diet to reduce the toxicity of their food plants (Schmidt *et al.* 2000). This orange coloured, viscous liquid drips from the larval masses in large quantities, which can stain the bark of the host tree. This defensive behaviour has been recorded for other species of Perginae (Carne 1962, Macdonald and Ohmart 1993). Leadership behaviour appears to occur with larvae following a leader to feeding sites or aggregation sites. Larvae move as a gregarious mass into the soil to pupate. Each larva forms an individual pupal capsule, most likely made of sand particles, faecal matter, silk and material from the repugnatorial gland (Macdonald and Ohmart 1993). The pupal capsules are divided into two chambers, separating the prepupae/pupae from the exuviae of the last larval moult. The pupal duration for field collected *A. cameronii* and *P. polita* ranged from 18-67 days and 58-231 days respectively. Both species were parasitised by tachinid flies. Emerging adults of both species are strong fliers, with males smaller than females. The larvae and adults of both species are brown, although the late instar larvae and adults of *P. polita* are both darker and larger than those of *A. cameronii*. The late instar larvae and adults of both species can be separated definitively by the cream coloured markings on the dorsal thoracic segments of *P. polita*, which are absent on *A. cameronii*.

The habits of *Perga vollenhovii* are largely unknown, although the larvae form gregarious masses and feed on young foliage, as in the other two species of Perginae. In the laboratory, the prepupal/pupal duration is approximately 4-6 weeks. Larvae, which were collected from only two sites in the months of July or August, were frequently parasitised by *Froggattimyia* Townsend sp. (Diptera: Tachinidae). Eighty percent of larvae were parasitized in one collection from Centenary Park in Cairns.

Pterygophorus insignis has habits which are very similar to those of *L. zonalis*, outlined in Burrows and Balciunas (1997). Larvae of both species appear identical. Adults of both species are similar, being black in colour with gold markings on the dorsal surface of the thorax and also on segments of the abdomen. However, the gold banding of the abdomen differs between the species. On *L. zonalis* abdominal segments 2-5 are gold, while on *P. insignis* only segments 2 and 3 are this colour. *P. insignis* also has gold markings on abdominal segment 7; these are absent on *L. zonalis*. Females are parthenogenic and lay batches of eggs along the margin of leaves. Larvae hatch and form a feeding front along both sides of the leaf, initially causing skeletonisation, followed by consumption of the whole leaf as the larvae mature. In later instars, the larvae feed individually or in groups of 2-3. Larvae feed throughout the day. Unlike *L. zonalis*, there are no distinctive pupation holes in the bark of the host tree and no pupae were found in the field. In the laboratory, pupation occurred in paper towelling or in paperbark from the host tree held in plastic containers. The prepupal/pupal duration ranged from 13-81 days.

Biological control

Only *Lophyrotoma zonalis* was considered as a biological control agent for *M. quinquenervia*. Because this sawfly pupates in the bark of the host tree, it will be able to complete its life cycle in the wetland areas of southern Florida, where *M. quinquenervia* is a serious weed. These areas are mostly permanently or seasonally inundated and any pupae beneath the soil would drown during flooding. The remaining four sawfly species collected in our surveys all pupate in the soil and would therefore be limited in their potential to build up sufficiently large populations to damage trees. They could only be effective in drier areas that were, at best, seasonally inundated, allowing immatures to complete their development. The field host ranges of *Pterygophorus insignis* and *Pergagrapta polita* are also too broad for biological control.

The three pergine species, *Acanthoperga cameronii*, *P. polita* and *Perga vollenhovii*, feed on young foliage, which is only produced seasonally following flowering. As in other members of this subfamily, these sawflies are likely to remain in a static condition as prepupae beneath the soil between seasons or longer (Macdonald and Ohmart 1993), leaving them exposed over long periods to possible flooding. Our longest prepupal/pupal duration for *A. cameronii* and *P. polita* was 135 days and 231 days respectively. Additionally, attacking the young foliage of *M. quinquenervia* in Florida is already being successfully addressed by the foliage feeding weevil *Oxyops vitiosa* Pascoe (Coleoptera: Curculionidae) and the sap-sucking psyllid *Boreioglycaspis melaleucae* Moore (Hemiptera: Psyllidae), released in Florida in 1997 (Center *et al.* 2000) and 2002 (Wood and Flores 2002) respectively.

Quarantine testing of *L. zonalis* has been completed in the United States and its host range is considered to be sufficiently narrow for release as a biological control agent. However, a related sawfly, *L. interrupta* Klug, has been implicated in cattle poisonings in a small area of southwestern Queensland (Roberts 1932, Dadswell *et al.* 1985, McKenzie *et al.* 1985a). The epidemiology and the possible causes of these poisonings are outlined in several studies (Oelrichs 1982, Dadswell *et al.* 1985, McKenzie *et al.* 1985b). Sawfly poisonings have also been recorded more recently on two other continents. In Europe, *Arge pullata* Zaddach (Argidae), the birch tree sawfly, has poisoned sheep and goats in Denmark (Thamsborg *et al.* 1987), while *Perreyia flavipes* Konow (Pergidae) has poisoned cattle and sheep in Uruguay, South America (Dutra *et al.* 1997, Riet-Correa *et al.* 1998). Two peptides, lophyrotomin and pergidin, have been isolated and identified as the toxins in these sawflies and the quantities of each peptide vary between the species (Oelrichs *et al.* 1999, 2001).

Lophyrotoma zonalis sawflies from the quarantine culture in Florida were sent to Dr Oelrichs for testing. Both peptides were isolated and both were

toxic to mice (Oelrichs *et al.* 2001). Even though large numbers of *L. zonalis* can be found defoliating *Melaleuca* trees in Queensland and the Northern Territory, there are no recorded incidences of livestock being poisoned. There are also differences between the larval habits of *L. zonalis* and those of other sawflies that have been implicated in animal poisonings around the world.

Unlike these other sawflies, *L. zonalis* larvae pupate individually in the papery bark of *Melaleuca* trees, inaccessible to many animals, especially livestock. The sawflies involved in cattle poisoning pupate in the soil and are accessible to livestock. Species like *L. interrupta* form large gregarious masses at ground level on which the cattle feed. If *L. zonalis* were released in Florida, the major concern would be for birds, reptiles and small mammals which could access the larvae in the trees. However, as a defence mechanism, the larvae of *L. zonalis* regurgitate fluid that possibly contains, or has been derived from, high concentrations of essential oils found in the leaves of *Melaleuca*. Therefore, they may be unpalatable to many of these animals. However, many starving migratory birds arrive in Florida after long flights over open water and, through desperation, may feed on them (T. Center pers comm.). Therefore, planned release of this agent has been temporarily abandoned. Toxicity trials using whole larvae may be performed in future.

Information on the toxic effects of agents for biological control of weeds is rarely considered when candidates are being evaluated. Only two sawflies have been released as biological control agents (Julien and Griffiths 1998) and both are from the family Tenthredinidae. Biological control practitioners should be aware that any sawflies being evaluated as agents should be assessed for toxicity, considering that poisoning by sawflies from two families has occurred on three continents (Oelrichs *et al.* 1999).

Acknowledgements

We thank G.J. Bowman, D. Burrows, B. Brown, L.M. Brown, K.E. Galway, P.K. Jones, J.R. Makinson, C.R. Maycock and S.J. Miller for help in collecting and rearing insects. This study was funded by USA Federal and State of Florida Agencies: USDA-ARS-Office of International Research Programs; US Army Corps of Engineers (Jacksonville District); National Park Service; Florida Department of Environmental Protection; South Florida Water Management District; Lee and Dade Counties, Florida.

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P.O. Box 537,
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Australia

Printed by ColourWise Reproductions, 300 Ann Street, Brisbane, 4000.

THE AUSTRALIAN
Entomologist

Volume 32, Part 1, 11 March 2005

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ISSN 1320 6133